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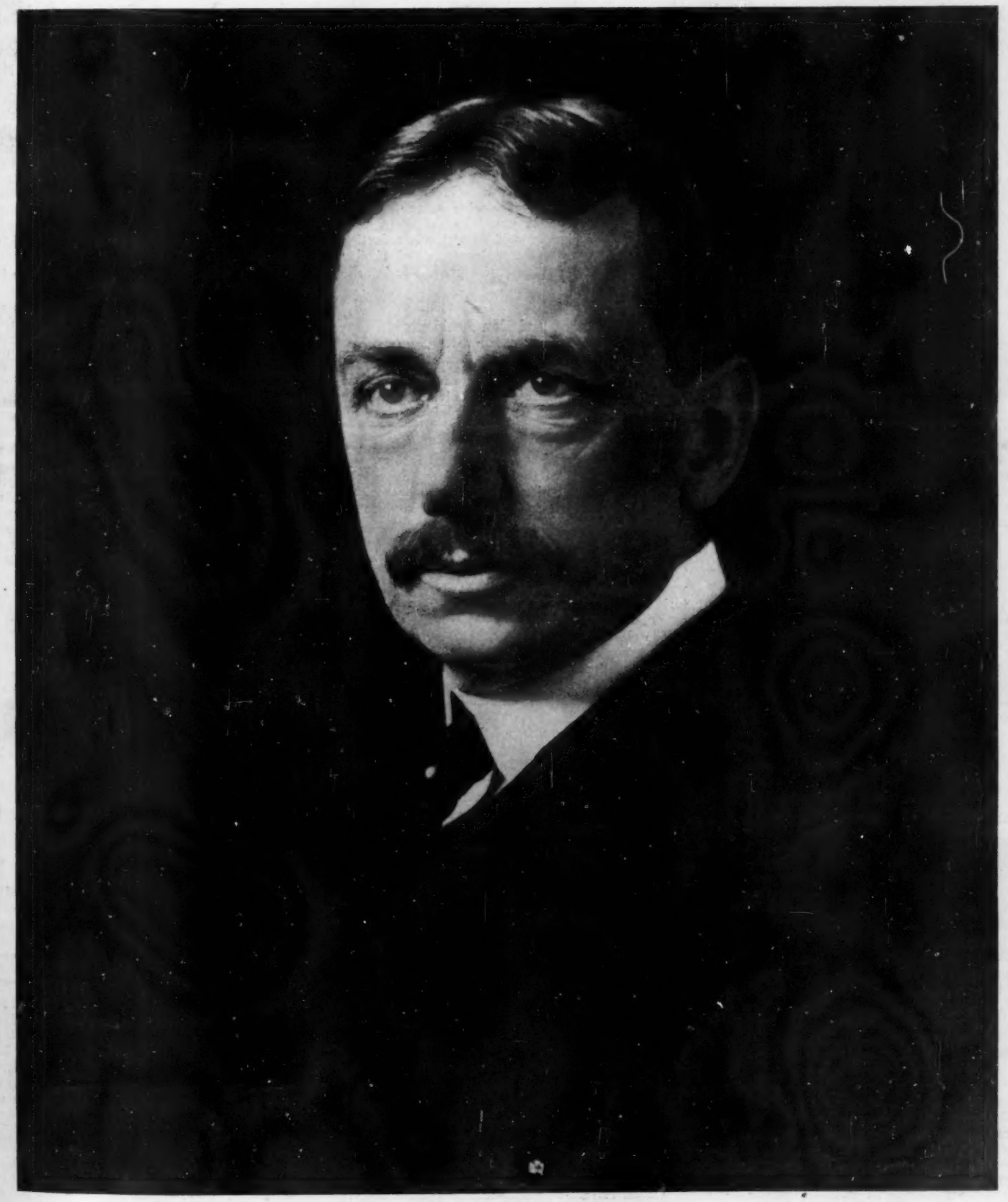

HENRY FAIRFIELD OSBORN

President of the American Museum of Natural History and America's foremost authority on fossils. –[See page 79.]

SCIENTIFIC AMERICAN

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately and in simple terms, the world's progress in scientific knowledge and industrial achievement. It seeks to present this information in a form so readable and readily understood, as to set forth and emphasize the inherent charm and fascination of science.

An Imminent Railroad Danger

WE are so much accustomed to speak of the perfection of the track and equipment of our leading railroads that the occurrence of such a disaster as happened last week at Bridgeport to the Washington express fills us with dismay and raises a very grave doubt as to whether we have even yet discovered how to make the modern high-speed train a perfectly safe means of travel.

Broadly speaking, railroad accidents are due to failure of either the physical or the human element—the roadbed and rolling stock or the operating employee. The Bridgeport accident, according to the statement given out by the officials of the road, was due immediately to the failure of the engineer in charge of the train; remotely, however, it must be regarded as due to track conditions, which, had they been other than they were, would have prevented the accident in spite of the carelessness of the employee.

The line of the New Haven Railroad at the scene of the accident is a four-track road, the outer tracks of which are mainly reserved for local or suburban service, and the two inside tracks for express service. At the stations the express trains, unless express platforms are provided, make use of the local platforms, crossing over for this purpose from the express to the local tracks at a point some distance back from the station. It is customary for the expresses to slow down on approaching the switch of the cross-over, and it seems that, in the case in question, the rules of the New Haven road call for a reduction of speed to fifteen miles an hour. The officials of the road have stated that the engineer ran his heavy express train over the switch at a speed that was nearly sixty miles an hour.

Now, at any such speed as this, the inertia of the engine was too great for the flanges of the wheels to do their work effectively in holding the train on the track. It "mounted" the rails and plunged down the embankment, with the result that some fourteen people were killed and half a hundred wounded.

Unquestionably, in this day of high-class track and rolling stock, the most prolific source of accidents on railroads is the failure of the human element. For some reason which will never be explained, since the man is dead, the engineer either failed to observe or to obey both the signals and the speed regulation. It was hot weather and he had gone through a heavy day's work—possibly he was in a state of physical weariness which caused a temporary mental lapse. Whatever the explanation, the fact remains that we have here one more railroad disaster attributable to human failure; and the question immediately presents itself, "Would it not be possible to arrange this matter of cross-overs or turn-outs for fast trains, so that the safety of the train would be automatically taken care of, and not be left dependent on the mental and physical condition of the engineer?"

The answer to this question is that it would be entirely possible, in the great majority of cases, to so construct these cross-overs that even if regulations as to slow running were overlooked or disobeyed, an express train would run through from one track to the other without any serious risk of derailment. This could be done by making the cross-over extend over a greater distance, measured along the axis of the roadbed, and making the angle of the frogs, switches, etc., as small as is compatible with structural requirements. It would be entirely possible to lay out the track with switches and curves so easy that if a heavy express train disobeyed its orders (say for a 30-mile speed at the cross-over), and swept over it at a speed of 60 miles an hour, it could do so without any grave risk of derailment.

Now we understand that at least one of our leading railroads has already adopted this plan. Its cross-overs are so gradual and the length of the cross-over between switches is so great, that the trains are swung from one track to the other, even when they are running at high speed, at the will of the signal man, and without the imposition of any speed reduction upon the engineer. These are the ideal conditions; for construction of this character eliminates entirely a risk of operation, whose magnitude is only appreciated in the presence of such a frightful disaster as that which recently occurred near Bridgeport.

We commend this most important subject to the joint consideration of the Interstate Railroad Commission, and of the maintenance of way engineers of our railroads. The lengthening out of cross-overs would be one more step in the elimination of the human element as a predisposing cause for accidents, and therefore it would be consistent with the policy which has brought about the introduction of the automatic block signal system and similar safety appliances for the protection of life in railroad travel.

Causes of Aviation Accidents

ACCORDING to the conclusions of Lieut.-Col. Boutticaux, who has just prepared a careful report upon the principal causes of serious aviation accidents, these may be divided into four classes, due respectively to faults of construction, mistakes of the pilot, state of the weather, and finally, either to the fault of the public or to one of a variety of special or ill-determined factors.

Up to the first of the present year, there is a record of 31 fatal accidents, costing the lives of 34 persons. Of these, twice as many took place in 1910 as in 1909; but if we take into account the fact that the number of aviators had been quintupled, the proportion descends to 40 per cent of the previous year. Seventeen of these accidents were due to bad construction, 2 to atmospheric perturbations, 9 to faults of the pilot, and 3 to other causes.

The classification of *simple* accidents, i. e., those without tragic results, gives in the above-mentioned classes the figures 26, 27, 33, and 31. Hence, in the total, 29 per cent of these accidents are imputable to the construction and 27 to the piloting of the machines.

The following summary of the accidents per year is illuminating: First, imperfect construction was responsible for 14 accidents, 1 of which was fatal, in 1909, and in 1910, for 29 accidents, 16 of which were fatal. Second, errors of pilot caused 21 accidents (1 fatal) in 1909, and 21 accidents in 1910, of which 8 were fatal. Third, atmospheric disturbances caused 4 accidents (none fatal) in 1909, and 25 (2 fatal) in 1910. Fourth, imprudences of spectators or aviators and other special or ill-determined causes were responsible for 8 accidents (1 fatal), in 1909, and for 26 accidents in 1910, of which 2 were fatal. The total number of accidents in 1909 was 47, and in 1910 there were 101 accidents.

The increase of accidents due to atmospheric conditions is explained largely by the fact that in 1909 aviators dared not risk their lives in all sorts of weather, as they began to do later, while the greatly increased number of aviation meets had as a corollary an increase in the number of accidents of class 4, caused by faults of spectators or collisions in a restricted landing place.

Faults of construction may be divided into those which may be ascribed to the principle of the machine, and those due to imperfect execution of a plan theoretically perfect. The proportion of the first to the second is as 2 to 43, which does honor to the conception of the aeroplane.

Among accidents of construction, those involving the wings amount to 18, and they frequently were due to a rupture at the line of union with the fuselage, especially in monoplanes. The results are among the most terrible, with 11 cases fatal, and the others very serious. Those ascribable to the motor or controls were 17 in number, of which 5 were fatal. The propeller entered into 6 accidents, in 5 of which it was of metal.

Errors of pilotage brought about 42 accidents, of which 9 were fatal. Among these, faulty turns entered into 24, of which 3 were fatal, while the manner of landing occasioned 8, of which 5 were fatal.

Too sudden an ascent, causing a loss of sustaining power to the machine, in consequence of the insufficient power of the motor, caused 9 accidents, with 1 fatality.

Of reciprocal injuries between aviators, 5 resulted from too close a proximity of passage and the resulting air "wash."

There is nothing to show whether biplane or monoplane is the more subject to accidents, for if more fell to the share of the former, that is due, for the moment at least, to the circumstance of their majority; the percentage was about the same.

How may these causes of accident be overcome? The author of the report advises, in the first place, the use by pilots of helmets, belts, and other safety devices in the shape of garments, which will be efficacious in cases of moderate fall. For machines he recommends shock absorbers and especially a lightly-constructed prow, the breaking of which would serve to deaden the shock. It would, in fact, be desirable that special experiments should be made with reference to the localization of a weak point upon which the initial effect of a shock would be expended, just as in every electric circuit a fuse is introduced at some point where will be localized the effects of a chance excess of voltage.

As for parachutes, their tests have thus far been too few to be commented upon.

Dangers from faulty construction may be minimized by demanding a certificate of navigability and enforcing certain requirements of construction with reference to the choice of materials and the strengthening of the controls.

For the pilot the addition of automatic stabilizing apparatus would be desirable; but these must be practical and efficacious, which is at present only a hope. Equally useful would be instruments indicating loss of speed, exaggerated incidence, lateral sliding toward the center in turning, etc.

The education of the pilot, improving progressively, on his part, will tend to eliminate risks of aviation, while greater difficulty in obtaining a pilot's license will, to some extent, limit accidents to the period of apprenticeship. Casualties due to meteorological conditions are more difficult to avoid, if not impossible. The best remedy would be a deeper knowledge of meteorology and topography, and the making of appropriate topographical maps will contribute to this end. The education of crowds, as well as fewer aviation meets, will diminish the risks occasioned by them.

The conclusions of the report are very encouraging. Bouttieaux proves that the increase of accidents, so alarming at the first view, arises from the great progress made by aviation, and this in spite of the indisputably rudimentary character of several of the machines. The improvement of these, whose era is just dawning, will render them steadily safer and more manageable, till a reasonable degree of safety is assured.

The Albedo of Clouds

THE albedo of clouds varies between wide limits, but was formerly assumed to average about 0.75; i. e., the upper surface of the clouds was supposed to reflect about 75 per cent of the incident sunlight. The albedo of white paper is 0.70; of new-fallen snow 0.78. The first attempts to measure accurately the albedo of a layer of clouds seen beneath an observer posted on the top of a mountain were those made by Abbot and Fowle on Mount Wilson in 1906, and gave an average of 0.65, but this result was later found to be doubtful, owing to errors in reduction. Within the past few months this problem, which has such important bearings upon the physics of the earth's atmosphere, has been taken up in Germany by Messrs. Stuchtey and Wegener, who made numerous measurements with a specially constructed albedometer in the course of several balloon voyages. They found the following values, which have been corrected by eliminating the general radiation of the sky, and refer only to the proportion of direct sunlight reflected: Lower stratus clouds, 0.54; higher stratus, 0.76; cumulus, 0.67. They also measured the albedo of the earth's surface as seen from altitudes between 600 and 1,650 meters. The albedo of open fields was found to average 0.15; of woods, 0.06.

The Winning of the International Aviation Trophy

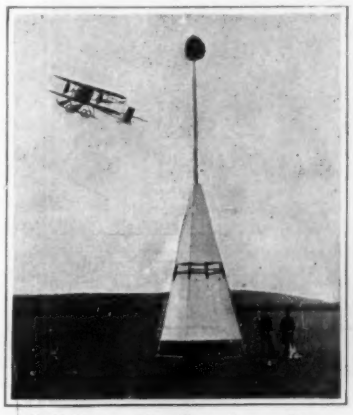
How Weymann Upheld Our Colors Single-handed and Won the World's Greatest Speed Event

THE third international aeroplane race for the Bennett trophy was held at the Isle of Sheppey, Eastchurch, England, on July 1st, and for the second time America came out victorious, although she had but one representative against the three each of France and England. After attempting to get the Wrights and Glenn H. Curtiss to represent America this year in the race, the Aero Club officials finally secured Charles T. Weymann, the young aviator who has made a name for himself in aviation abroad, to endeavor to bring back the cup to America. It was first won in 1909 by Glenn Curtiss, who went to France with his own machine and beat Blériot with his fast monoplane. Last October, at Belmont Park, Grahame-White won the race on account of an accident to Leblanc, Blériot's chief pilot. The Englishman won on a Blériot monoplane, as there was no rule requiring the machine to be built in the country which it represented. The Nieuport monoplane, during the past six months, has proved itself to be one of the fastest and one of the most efficient aeroplanes; and as there was no rule forbidding it, Mr. Weymann decided to use one of these machines, which he has flown considerably of late. He was obliged to abandon the Paris-London-Paris circuit race, in which he was among the leaders, at Utrecht, in order to fly in the cup race; but the result of the race amply justified him in doing this.

For the past eight or nine months M. Blériot has been experimenting upon speed machines. Several months ago we gave information about his latest speed monoplane, which had a peculiar shape of wing and was fitted with a powerful motor. Blériot experimented with a 140-horse-power 14-cylinder Gnome motor, and it was thought that the machine for the race would be equipped with one of these engines, as well as with the peculiar shape of wing, with flexible rear edge, with which he had had his greatest success. When M. Leblanc appeared at Eastchurch with a machine having wings of only one meter width and a total spread of nine meters, or, in other words, nine square meters (96.876 square feet) surface, and fitted with a 100-horse-power Gnome motor only, he sprang a surprise upon aviation enthusiasts, who doubted whether he could win the race with such a diminutive machine, equipped with no more powerful motor than he used last year. The Nieuport monoplanes, however, had only 70-horse-power motors, and considerably larger wings. One of them, driven by Chevalier (who was the third man on the French team), had only a 50-horse-power Nieuport motor. Nieuport himself drove a 70-horse-power Gnome-engined machine, as did also Charles T. Weymann.

The English team was made up of G. Hamel on a 100-horse-power Blériot, which was practically a duplicate of Leblanc's; Alec Ogilvie, on a baby Wright fitted with a 50-horse-power N. E. C. two-cycle motor; and Graham Gilmour, on a Bristol monoplane. As reserves, England had Messrs. J. Radley, J. Valentine, and O. C. Morrison. Mr. Radley flew in the Bennett race last year, as did also Mr. Ogilvie. The latter completed the race last year on a Wright biplane, and secured third place. This year he used an English-built Wright machine constructed under the supervision of Wilbur Wright, and fitted with a four-cylinder V-type two-cycle motor, recently illustrated in our columns.

The reserve members of the French team consisted of Aubrun, who flies a Deperdussin monoplane; Vedrines, the Morane pilot; and Gibert, with his R. E. P. The Frenchmen had on hand at the time of the race four extra Nieuport monoplanes, three Blériots, two Deperdussins, and one R. E. P. A number of trial flights were made on Thursday and Friday, June 29th and 30th, by Weymann, Nieuport, and one or two other members of both the English and French teams. The Nieuport monoplane was booked as the winner, and it was thought that Weymann stood an excellent chance. July 1st dawned clear and pleasant, although there was considerable wind in the morning and early afternoon. The race was scheduled to start eight hours before sundown, but the flying did not begin until about 3 P. M., at which time the wind was blowing at less than twenty miles an hour. The course was six kilometers (3.72 miles) in circumference, and was over level, smooth ground. Its only disadvantage was its proximity to the sea, which, of course, was responsible for the rather stiff breeze that blew some of the time.

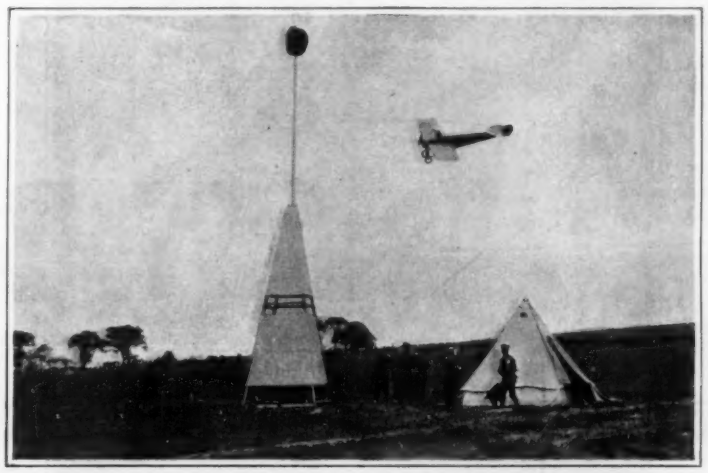


Ogilvie rounding the pylon on his baby Wright racer.

Note the sharp angle at which the aviator is ascending. This is to allow for dropping of the machine in making a turn.

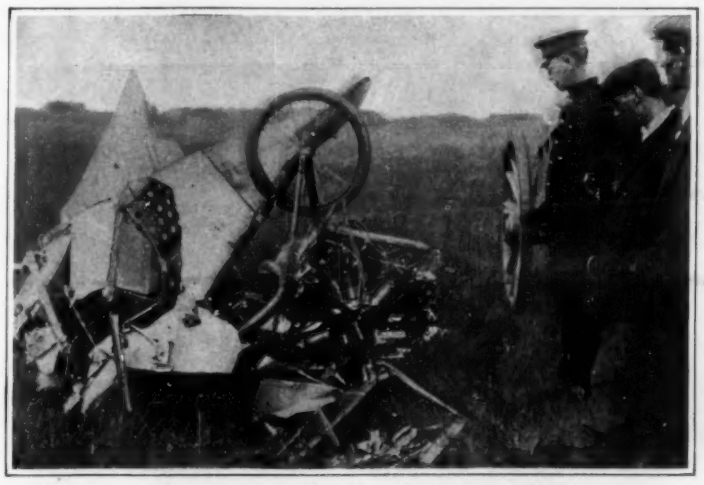
Leblanc doing 75 miles an hour on the straightaway.

Note the narrow wings and the finely tapering lines of the body of his high-powered machine.



Weymann, the winner of the race, rounding the pylon at 80 miles an hour.

The fusiform shape of the body (which is entirely covered with cloth) is well shown in this picture. It is to this form that the greatly diminished head-resistance is largely due.



Wreck of Hamel's Bleriot. The aviator escaped uninjured.

The 14-cylinder, 100-horse-power Gnome motor is clearly seen, as is also the specially tapered fuselage used on this racing monoplane.

SCENES AT THE GREAT RACE.

Gustave Hamel, the English aviator, was the first to start, which he did at 3 P. M. It was thought that he would do well, as he had made an excellent showing in the morning while practising. Instead, he banked too much on making the turn on his first round of the course and his machine slid sideways to the ground, and was smashed to pieces. The aviator luckily escaped without any serious injuries. Shortly after Hamel's accident, Weymann started in his Nieuport monoplane. He rose to the height of 100 yards or so, which elevation he maintained throughout the entire twenty-five circuits of the course. He covered the first five circuits (30 kilometers) in 14:00 2/5. Chevalier was the first Frenchman to start. He flew fairly well in his low-powered Nieuport, but alighted after completing ten laps, and did not finish the race.

As Gilmour withdrew, England's only remaining representative was Ogilvie, who flew his baby Wright in excellent fashion, though he was unable to make anything like the speed of the Nieuport or Blériot monoplane. Nieuport covered the first five circuits in 14:46, whereas Ogilvie required 21:45 to fly the same distance (18 miles). Leblanc was the last to ascend. He covered the first circuit in practically the same time as Nieuport, and at the end of ten laps, which he covered in 29:29 4/5, he was only four seconds ahead. He was still ahead of his compatriot at the end of fifteen laps, and although he succeeded in the end in beating the latter by 57 seconds, he failed to beat Weymann by 2 minutes 2 4/5 seconds.

The time of the winner in the race was one hour, eleven minutes, thirty-six and one-fifth seconds, which corresponds to an average speed of 78.1 miles an hour. Leblanc was second in 1:13:40 1/5—an average speed of 75.91 miles an hour. The third place went to Nieuport in 1:14:37 3/5 (74.94 miles an hour), and fourth to Ogilvie, in 1:49:10 2/5 (51.22 miles an hour). Chevalier's time for his ten laps was 37:37 1/5. This corresponds to an average speed of 59.3 miles an hour, which is very good, considering the low power of his machine.

The winning of the race by America should serve to stimulate aviation in this country greatly, especially since next year the rules will probably be changed so that the machine and pilot must both be the production of the country which they represent. As speed is the desideratum of the racing aeroplane, and the thing for which it exists, we believe that if our inventors can develop the speediest, and at the same time the safest, flying machines, they will again cause America to lead the world in aviation, just as she did at the start.

South Sea Swells

WE all remember with what frequency in the old narratives of experiences in the South Seas reference is made to the heavy swells of the ocean, which impressed the navigators with the idea of their remoteness from land.

The great size of the sea waves in high Southern latitudes has been explained by the fact that south of the Cape of Good Hope and Cape Horn there is neither windward nor leeward shore, and the prevailing wind in all longitudes is westerly. Thus when a west wind springs up it finds a long westerly swell, the effect of a previous wind, still running. The new-born wind increases the steepness of this swell, and so forms majestic storm waves, which sometimes attain a length of 1,200 feet from crest to crest. The average height attained by sea waves in feet is about half the velocity of the wind in miles per hour.

The Beacon Hill Tunnel

How a Half-mile of the Boston Subway Was Built in Tunnel

By G. D. Emerson

THE most recent underground construction in the Boston district for the use of street railway traffic is the tunnel through Beacon Hill, which is now nearing completion. This tunnel, which is a little less than half a mile in length, does not follow the street lines, but runs through the middle of Beacon Hill in a general northwesterly and southeasterly direction, connecting at its northwesterly end with an elevated structure which will cross the Cambridge bridge over the Charles River, and at its southeasterly end terminates at present in a station beneath Boston Common, under the Park Street station of the Tremont Street subway. The bottom of the tunnel, at the deepest point, is about one hundred feet below the top of the hill. This tunnel forms the Boston end of the new subway lines connecting Harvard Square, Cambridge, with the business section of Boston.

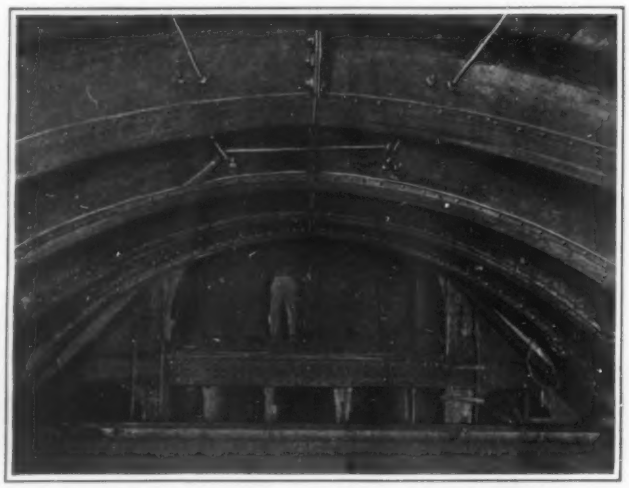
Beacon Hill is presumably a glacial formation, and is composed in general of a very hard mixture of blue and yellow clay and sand, together with numerous small stones and a few large boulders. Irregular streaks and pockets of sand, some containing water, were frequently encountered during the progress of the work. No serious difficulty resulted, however, from the ground-water, and this, together with the hardness of the ground, made it unnecessary to do any of the work in compressed air, although there was a provision in the contract for the work for doing so in case of necessity. At one point, about sixty-five or seventy feet below the surface, some worn fragments of clam shells were found imbedded in the hard blue clay.

The general method of tunneling adopted for this work was by means of a roof-shield, which is quite similar in character to the shields used in the tunnels already constructed in this vicinity: The Tremont Street tunnel of the original subway, the East Boston tunnel and the Dana Hill tunnel of the Cambridge subway.

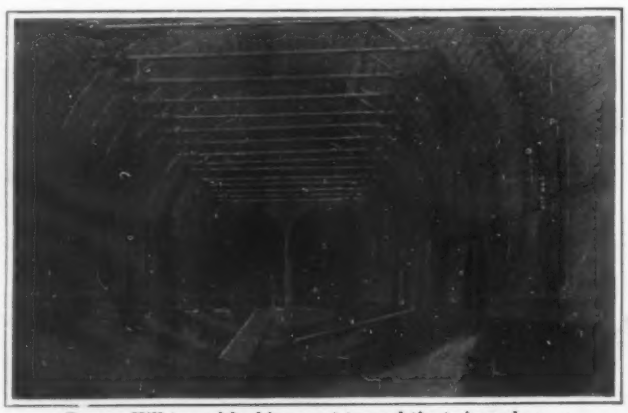
This roof-shield is essentially a semi-circular steel frame weighing about sixty-five tons, the diameter of which is equal to the outside width of the tunnel, which is thirty-two feet four inches. Its function is to support the earth above the roof of the tunnel temporarily, while the permanent concrete tunnel arch is being built below.

The first operation in this method of tunneling is to dig two small pilot-tunnels—or so-called side-wall drifts. These drifts are about nine feet square, the roof and sides being timbered, and they are located at the bottom outside corners of the tunnel section. As fast as they are excavated, the lower part of the concrete side-wall of the tunnel is built in them. They are kept from one hundred and fifty to two hundred feet in advance of the shield, so that the concrete walls will have sufficient time to harden before the weight of the shield comes on them. The shield, which rests on cast-iron rollers, is pushed along on top of these concrete side-walls by means of hydraulic jacks.

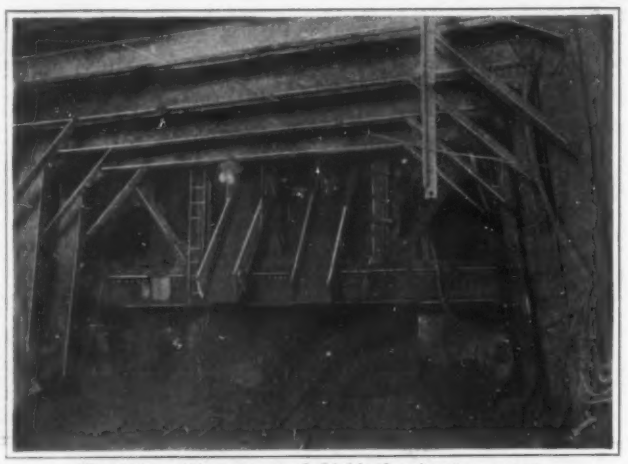
The successive operations are as follows: The earth is excavated for two and one-half feet ahead of the shield, which is then shoved forward through this distance by means of the hydraulic jacks before mentioned. A section of the concrete arch two and one-half feet long is then built under the overhanging steel plates at the rear of the shield. The soft concrete is placed on temporary steel centers or supports, which are removed after it has become sufficiently strong. The overhanging plates at the rear of the shield are about one and a quarter inches thick, and when the shield is shoved forward it leaves an annular space of that thickness between the concrete arch and the earth. This space is filled as soon as practicable by pumping in liquid cement grout. In actual work, the operations of excavating ahead and putting in concrete at the rear of the shield are carried on simultaneously. This cycle, which takes about five or six hours, is repeated continuously.



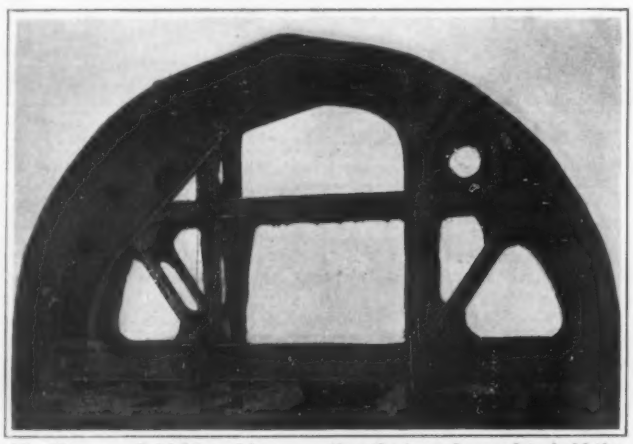
View of steel centers and shield from upper working deck.



Beacon Hill tunnel looking west toward the twin arches.



Rear view of lower part of shield, showing temporary steel centering behind it.



The 65-ton roof-shield used in excavating the tunnel served to hold the earth above roof in place while the permanent concrete arch was being built below it.

A rear view of the lower part of the shield in actual operation, and showing some of the temporary steel centering immediately behind it, is shown herewith. The upper half of the shield in working condition is also illustrated. As fast as the excavation is completed, and the concrete arch is in place, the concrete bottom is put in.

All machinery for operating the shield and hauling the working-cars in the tunnel is run by compressed air furnished by a compressor plant located near the mouth of the tunnel. As stated above, the shield is shoved ahead by hydraulic jacks, of which there are fourteen, spaced equally around the circumference of the shield. These jacks have plungers eight inches in diameter and work under a maximum pressure of four thousand pounds to the square inch, which gives a maximum pushing force of nearly one hundred tons for each jack, or about one thousand four hundred tons for the whole shield. The jack-cylinders are bolted to the frame-work of the shield and the plungers push against lines of cast-iron rods which are imbedded in the concrete arch. The water, under pressure, for operating the jacks, is furnished by two pumps which are run by compressed air.

Economy in this kind of construction depends to a large extent upon systematizing and specializing the work. Thus, several different gangs of men do the excavating in the pilot tunnels and on the shield platforms, others put in the concrete walls in the pilot tunnels and the concrete arches at the back of the shield, and still others attend to setting up and taking down the temporary concrete supports, handle the cars which bring in fresh concrete and take out the excavated earth, etc. Each of the different operations is repeated continuously so that by proper systematizing the labor becomes very efficient. Most of the work was carried on by two ten-hour shifts per day, the number of men in each shift averaging about one hundred and thirty. The average progress per twenty-four hours was seven and a half feet, and the maximum progress per 24 hours was about nine feet.

The surface of the hill, over the line of the tunnel, is thickly covered with brick buildings from three to six stories in height. The excavation was carried on in such a manner, however, as to avoid any settlement or damage to them.

During the course of the work about a dozen old wells that used to furnish the water supply for former residents on Beacon Hill were encountered in the tunnel headings. Some of these old wells were one hundred feet deep and more than a century old, and the hollow pump-logs were still in place, and in fair condition. The first intimation the tunnel workers had of their existence was when the stone lining of the wells fell down into the tunnel when they were reached by the excavations. This resulted in some delays, but no very serious difficulties.

The chief item of interest toward the end of any construction of this sort is where the tunnel "comes out," that is, how close the engineers have been able to run their lines to the theoretical position the tunnel should occupy. Part of this tunnel is on a curve of four-thousand-foot radius, which makes the running of the survey lines somewhat more difficult than if the line were straight. In this particular case the tunnel came out at the final end within less than half an inch of its calculated position.

The Beacon Hill Tunnel is being built for the city of Boston by the Boston Transit Commission, and, upon completion, it will be leased to the Boston Elevated Railway Company.

A Comparison of the German and American Navies

Our Great Superiority in Gun-fire Places the United States in the Lead.

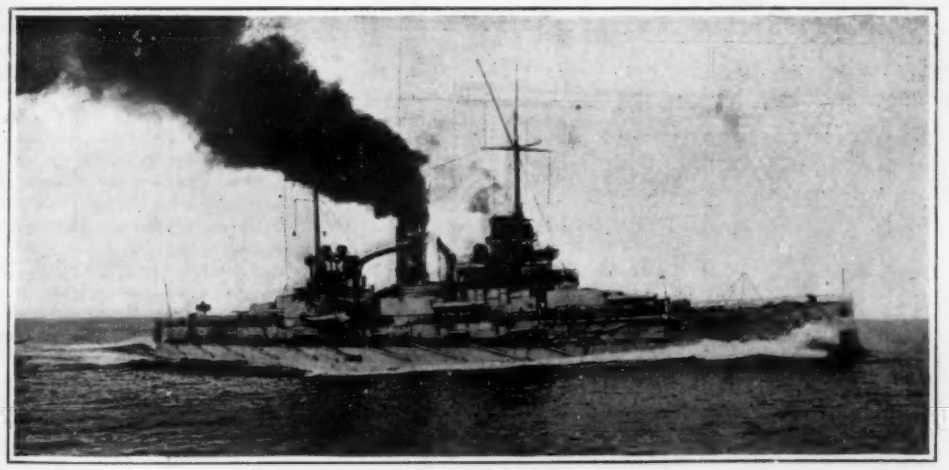
By H. D. Brandyce

ONE of the most fruitful topics of the day seems to be the phenomenally rapid growth of the German Navy; and the notion is widely held that the Kaiser is adding to his fleet for the purpose of challenging England's age-long supremacy on the sea. Now, whatever may be the Kaiser's idea, such a contingency is not likely to be realized for many years to come, for not only is Germany's naval strength still far inferior to Britain's, but it is at the moment of writing also vastly less than our own.

Until the year 1910 those who made it their business to rank the various fleets of the world had assigned second place to the United States Navy, England holding first position and Germany third; but in the last twelvemonth these critics have seen fit to attribute to Germany a superiority which in our opinion is not borne out by fact. The only fair way to estimate the relative strength of the two navies is to take them ship for ship and compare their respective offensive and defensive qualities. The tonnage method which most naval writers employ is misleading, for it lumps together the armored and unarmored ships, and takes no account of age or design. In this way four unarmored cruises would equal one battleship, and twelve destroyers would rank with one armored cruiser. Obviously the proper means of obtaining relative values is to oppose battleship to battleship, armored cruiser to armored cruiser, as they would presumably line up in actual conflict. And, further, these ships should be as near as possible of equal age, for of course the newer vessels are not only larger but also more powerful than those of earlier date.

Displacement, 18,500 tons. **Speed,** 20 knots. **Coal,** 2,700 tons; **oil,** 200 tons. **Main battery,** twelve 11-inch; **secondary battery,** twelve 6-inch. **Main belt,** 9¾ inches; **upper armor,** 8 inches; **turrets,** 9¾ inches.

German Dreadnought "Westfalen."



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German Dreadnought "Nassau."

We need only concern ourselves with four classes of ships—battleships and armored cruisers, destroyers and submarines; for the functions of protected cruisers and gunboat are almost negligible from a military point of view, their activities being properly confined to police duty in time of peace, and, in time of war, to scouting and intelligence service. Of the four classes which we shall consider, the battleship is all-important; it takes its place in the forefront of the line of battle, and bears the brunt of the fighting. The armored cruiser is the heavy cavalry of the sea, and but rarely takes its place where the fire is hottest.

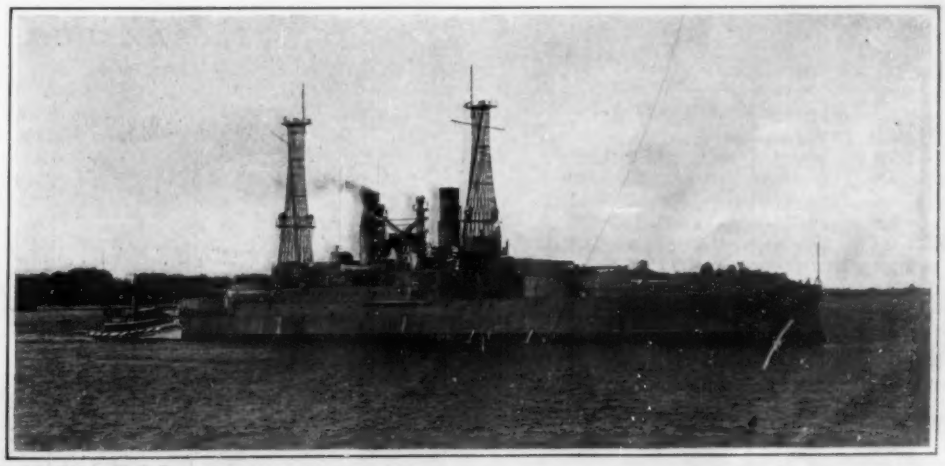
In making comparisons of the ships of these two navies, the dearth of positive information on subjects relating to the efficiency of the personnel of the Kaiser's fleet requires that in all matters dealing with the personal equation the two services be considered on a parity. We know nothing definite of the Germans' proficiency in battle practice or in steaming trials; but we may be quite sure that the thoroughness which is characteristic of their nation has brought these things to a high state of perfection.

But no matter how much they may practise at the targets, they cannot overcome deficiency in materials; inferior guns must give inferior results; for, strange as it may seem, Germany, the home of the Krupps and the Ehrhardts, has at this moment not one gun afloat which can pierce our battleships' side-armor at what we call battle range (8,000 yards)! This is a startling fact, and one which must be of supreme importance in making a fair comparison of the offensive power of the two fleets. In our annual battle practice the battleships commence firing at the targets when they are some 12,500 yards away, and their firing time is generally exhausted before they have approached to within 8,000 yards of the canvas screens. Yet the result is often the complete demolition of the target, although the mark is a rectangle less than one-fourth of the area of the broadside of a modern man-of-war.*

* The U. S. armored cruiser "Maryland" won the battleship trophy for 1910 by making 40 per cent of hits with her 8-inch guns at 10,000 yards in a heavy sea.

Little or nothing is known about the conditions under which the German High Sea Fleet conducts its shooting, but it is highly probable that their ranges are less than ours, for their lighter guns could not hope to score hits at over 10,000 yards, owing to the fact that the high angles at which they must fire at such great distances would tend quickly to impair the accuracy of their aim. Their new 11-inch guns of 45 caliber†—with which, by the way, only their dreadnoughts are equipped—have a very high muzzle-velocity (3,250 foot-seconds), but the relative lightness of the shell (595 pounds against 850 pounds for our "twelves") tends to a rapid falling off in velocity at anything above a point-blank range. So that while at 3,000 yards—which is almost point-blank—their armor-piercing shell will penetrate 22 inches of Krupp armor to 20 inches for our 12-inch A. P. shell, at 8,000 yards the penetrations are 8½ inches and 11 inches respectively. All this means that in case of actual hostilities between Germany and the United States our vesse's in the line of battle could fire with effect at the German battleships at ranges at which the latter could not seriously injure the vitals of our men-of-war. Of course they could do great damage to our upper works and lightly protected ends; but in the meantime—and before they could close in—our heavy artillery would presumably have shot their side-armor to pieces and pounded their turrets until they jammed and were incapacitated for further firing. (At the battle of Tsushima the Japanese sank many of the Russian battleships by long-range firing, the impact of the heavy projectiles against the belt-armor tending to fracture the plates and start the seams, so that the water entered in sufficient quantities to flood

† The word "caliber" is here used to express the length of the gun in terms of the diameter of the bore: thus a 12-inch gun of 45 calibers would have a length from powder-chamber to muzzle of 45 feet.



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Displacement, 16,250 tons. **Speed,** 18.5 knots. **Coal,** 2,200 tons. **Main battery,** eight 12-inch; **secondary battery,** twenty-two 3-inch. **Main belt,** 12 inches to 10 inches; **upper side,** 10 inches to 8 inches; **turrets,** 12 inches to 8 inches.

United States Dreadnought "Michigan."

the compartments and ultimately cause the ships to turn turtle.)

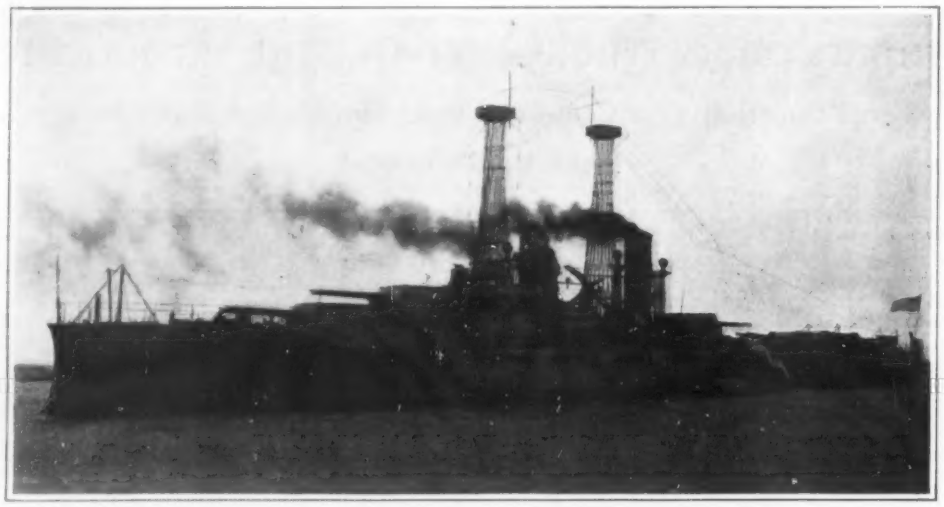
In the matter of armor protection there is little to choose between the fleets of the two powers when the ships are compared individually, according to date of launch. The same holds true of the relative speeds. In coal supply the Americans have a slight advantage, as may be seen in the appended tables.

The twenty-six German ships given in the table have a total displacement of 339,220 tons, an average of 13,047 per ship. This compares with a total for the Americans of 407,650 tons, and an average of 14,057. Let us now examine somewhat more closely into the guns and armor of the later models—say the fourteen most recent Germans and the twenty newest Americans.

Taking first the four "Westfalens." They carry twelve heavy guns each, but these are so arranged that only eight of them can fire on either broadside. The ten heavy guns of the "Delawares," in pairs in five turrets on the center line, can all fire on either broadside, which gives the Yankee dreadnoughts an immense advantage; and even the relatively small "Michigans" can oppose the German 11-inch guns with an equal number of 12's. Now at 8,000 yards the 11-inch gun can pierce only 8½ inches of Krupp steel on direct impact, and all the vulnerable parts of the United States ships are covered with from 12 to 8 inches of Krupp armor, and their turrets and barbettes are protected by slanting plates 12 inches thick. Our 12-inch 45-caliber rifle, on the other hand, can send a shell through 11-inch Krupp steel at 8,000 yards, and not one of these four German dreadnoughts mounts a plate more than 9¾ inches in thickness, except on the barbettes. Is it not plain, then, that the four Yankee vessels, with their thirty-six 12's in broadside, are more than a match for the four "Westfalens" and their thirty-two 11's?

The discrepancy between the ten "Hannovers" and the sixteen contemporary battleships of the American navy is even more startling. The German main belts vary from 9 to

(Continued on page 90.)



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Displacement, 20,300 tons. **Speed,** 21 knots. **Coal,** 2,340 tons; **oil,** 600 tons. **Main battery,** ten 12-inch; **secondary battery,** fourteen 5-inch. **Main belt,** 11 inches; **upper side,** 10 inches to 8 inches; **turret,** 12 inches to 8 inches.

United States "Delaware."

Able to Pierce Inches Krupp at 8000 yds.	9.4 in. 40-cal.	11 in. 40-cal†	11 in. 45-cal†	No. of Ships in Class	Name	Name	No. of Ships in Class	12 in. 45-cal†	12 in. 40-cal†	13 in. 35-cal. ("Iowa." 12 in. 35-cal.)	Able to Pierce Inches Krupp at 8000 yds.
8½			32	(4)	"Nassau"	"Delaware"	(2)	20			11
						"Michigan"	(2)	16			11
6		40		(10)	"Hannover"	"Connecticut"	(6)	24			11
						"Idaho"	(2)	8			10
						"Georgia"	(5)		20		8¾
						"Maine"	(3)		12		8¾
4½	40			(10)	"Kaisers"	"Alabama"	(3)			12	6
2½	*8)			(2)	"Woerth"	"Kearsarge"	(2)			8	6
2	**4)					"Indiana"	(3)			12	6
						"Iowa"	(1)			4	4
	52	40	32					68	32	36	

† Only the main batteries are here shown. * Old 11-in. 40-cal. ** Old 11-in. 35-cal.

TABLE SHOWING COMPARATIVE OFFENSIVE AND DEFENSIVE POWER OF GERMAN AND AMERICAN CRUISERS.

Secondary Battery.	Main Battery.	Upper Side Main Turret.	Main Belt.	Coal Supply.	Sea Speed.	Displacement.	Date	Name.	Name.	Date	Displacement.	Sea Speed.	Coal Supply.	Main Belt.	Upper Side Main Turret.	Main Battery.	Secondary Battery.
10 6 in. 50-cal.	8 11 in. 45-cal.	4½ in. 8 in.	6 in.	?	25 to 28	18,700	1909	"Von der Tann"									
15 3.9 in. 40-cal.	12 8.2 in. 45-cal.	7 6 in.	6 in.	2300 & 200 oil	24½	15,500	1908	"Bluecher"	"Montana" "North Carolina" "Tennessee" "Washington"	1904 to 1906	14,500	22	2000	5 in.	5 in. 9 in.-5 in.	4 10 in. 45-cal.	16 6 in. 50-cal. 22 3.2in. 50-cal.
6 6 in. 40-cal. 20 3.9 in. 35-cal.	8 8.2 in. 40-cal.	6 in. 6¾ in.	6 in.	2000 & 200 oil	17* 22.5	11,600	1906	"Scharnhorst" "Gneisenau"	"California" "Colorado" "Maryland" "Pennsylvania" "South Dakota" "West Virginia"	1903 to 1904	13,500	22	2000	6 in.	5 in. 6½ in. to 6 in.	4 8 in. 45-cal.	14 6 in. 50-cal. 20 3.2 in. 50-cal
10 6 in. 40-cal. 14 3.9 in.	4 8.2 in. 40-cal.	4 in. 6 in.	4 in.	1600 1500 & 200 oil	21	9,050	1903 to 1904 1901 to 1902	"Roon" "Yorck" "Prinz Adalbert" "Friedrich Karl"	"Charleston" "Milwaukee" "St. Louis"	1904 to 1905	9,700	22	1500	4 in.	4 in.		14 6 in. 50-cal. 18 3.2 in. 50-cal.
10 6 in. 40-cal. 12 3.2 in.	2 9.4 in. 40-cal.	4 in. 6 in. Nickel Steel	4 in.	1500 & 200 oil	20	8,930	1900	"Prinz Heinrich"	"Brooklyn"	1895	9,200	21	1650	3 in. Harvey	none 8 in.	8 8 in. 35-cal.	12 5 in. 40-cal.
12 6 in. 40-cal. 10 3.2 in.	4 9.4 in. 40-cal.	none 8 in. Nickel Steel	8 in.	1200	18.5	10,700	1897	"Furst Bismarck"	"New York"	1891	8,200	21	1150	4 in. Krupp	none 7 in.	4 8 in. 45-cal.	12 5 in. 50-cal. 8 3.2 in. 50-cal.
						11,323	Av.	10 Ships	15 Ships	Av.	12,367						

* "Scharnhorst" injured 1909 and has been slow ever since.

COMPARATIVE POWER OF GERMAN AND AMERICAN BATTLESHIPS.

Secondary Battery.	Main Battery.	Upper Side Main Turret.	Main Belt.	Coal Supply.	Sea Speed	Displacement.	Date	Name.	Name.	Date	Displacement.	Sea Speed.	Coal Supply.	Main Belt.	Upper Side Main Turret.	Main Battery.	Secondary Battery.
12 6 in. 50-cal.	12 11 in. 45-cal.	8 in. 9¾ in.	9¾ in.	2700 & 200 oil	20	18,500	1908 to 1909	"Nassau" "Westfalen" "Posen" "Rheinland"	"Delaware" "North Dakota"	1908 to 1909	20,300	21	2340 & 600 oil	11 in.	10in-8in 12in.-8in.	10in.-12 45-cal.	14 5in. 50-cal.
									"South Carolina" "Michigan"	1908	16.250	18.5	2200	12in.-10in.	10in.-8in. 12in.-8in.	8 12in. 45-cal.	
14 6.7 in. 40-cal.	4 11 in. 40-cal.	8 in. 11 in.	9¾ in.	1800 & 200 oil	18	13,200	1905 to 1906	"Hannover" "Pommern" "Schleswig-Holstein" "Schlesien"	"Kansas" "Minnesota" "New Hampshire" "Vermont"	1905 to 1906	16,000	18	2314	9 in.	7 in. 12in.-8in.	4 12in. 45-cal.	8 8in. 45-cal. 12 7in. 50-cal.
14 6.7 in. 40-cal.	4 11 in. 40-cal.	8 in. 11 in.	9 in.	1800 & 200 oil	18	13,200	1904	"Deutschland"	"Idaho" "Mississippi"	1905	13,000	17	1750	9 in.	7 in. 12in.-8in.	4 12in. 45-cal.	8 8in. 45-cal. 8 7in. 50-cal.
14 6.7 in. 40-cal.	4 11 in. 40-cal.	5 in. 11 in.	9 in.	1600 & 200 oil	18	13,200	1902 to 1904	"Braunschweig" "Elsass" "Hessen" "Lothringen" "Preussen"	"Connecticut" "Louisiana"	1904	16,000	18	2200	11 in.	7 in. 10in.-8in.	4 12in. 45-cal.	8 8in. 45-cal. 12 7in. 50-cal.
									"Georgia" "Nebraska" "New Jersey" "Rhode Island" "Virginia"	1904	15,000	19	1700	11 in.	6 in. 12in.-8in.	4 12in. 40-cal.	8 8in. 45-cal. 12 6in. 50-cal.
14 6 in. 40-cal.	4 9.4 in. 40-cal.	5½ in. 10 in.	9 in.	1400 & 200 oil	18	11,830	1900 to 1901	"Wittelsbach" "Mecklenburg" "Schwaben" "Wettin" "Zahringen"	"Maine" "Missouri" "Ohio"	1901	12,500	18	2000	12 in.	7 in. Krupp 12 in. Harvey-Nickel	4 12in. 40-cal.	16 6 in. 50-cal.
14 6 in. 40-cal.	4 9.4 in. 40-cal.	none 10 in.	12 in.	1050 & 100 oil	18	10,790	1896 to 1900	"Kaiser Barbarossa" "K. Friedrich III" "K. Karl d. Grosse" "K. Wilhelm d. Grosse" "K. Wilhelm II."	"Alabama" "Illinois" "Wisconsin"	1898	11,550	16	1450	16½ in. to 14 in.	5½ in. 14 in. Harvey-Nickel	4 13 in. 35-cal.	14 6 in. 40-cal.
									"Kearsarge" "Kentucky"	1898	11,500	16	1210	16½ in.	5½ in. 17in.-15in. Harvey-Nickel	4 13 in. 35-cal.	4 8 in. 40-cal. 14 5 in. 40-cal.
									"Iowa"	1896	11,500	16	1780	14 in. to 11 in.	5 in. 14 in. Harvey	4 12 in. 35-cal.	8 8 in. 35-cal.
	4 11 in. 40-cal. 2 11 in. 35-cal.	none 5 in. Compound	15 in.	1050	15	10,060	1891 to 1892	"Brandenburg" "Worth"	"Indiana" "Massachusetts" "Oregon"	1893	10,300	15	1800	18 in. to 15 in.	5 in. 15 in. Harvey	4 13 in. 35-cal.	8 8 in. 35-cal. 4 6-in. 50-cal.
						13047	Av.	26 Ships	29 Ships	Av.	14,057						

Henry Fairfield Osborn

America's Foremost Palæontologist

By Benjamin C. Gruenberg

TO pursue science because it satisfies the human spirit, without any delusion as to the possible application of his results to the relief of pain or poverty, that is to be a "pure" scientist. Such a scientist is Henry Fairfield Osborn, one of the foremost palæntologists of America. When in 1906 he was tendered the great honor of election as secretary of the Smithsonian Institution, he gave as one reason for declining the post the fact that palæntology was of no immediate use to society and he would, therefore, not feel justified in asking for appropriations to enable him to carry on his costly researches at the probable expense of work more likely to yield results of practical value to the rest of us. But he gave as another reason the fact that the material, equipment and assistants necessary for carrying on his researches were located in New York—and with his work he would stay.

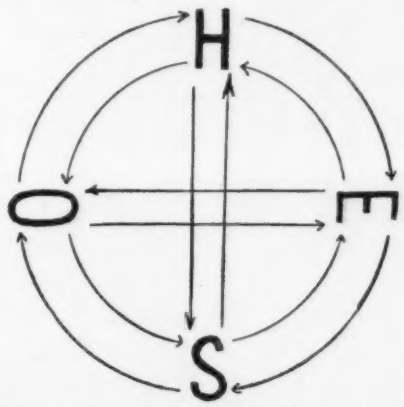
Prof. Osborn was born at Fairfield, Conn., August 8th, 1857, a descendant of merchants on both sides of the family. He received his collegiate education at Princeton, and commenced his career as organizer and manager of scientific research even before he was graduated by organizing and leading the palæontological section of the Princeton scientific expedition to Colorado and Wyoming in 1877. He studied geology under Arnold Guyot, anatomy under Wm. H. Welch, comparative anatomy under Huxley, and embryology under Balfour. While in England he was very much awed and inspired by a casual meeting with Charles Darwin when the latter was visiting Huxley's laboratory. He taught natural science at Princeton and studied in Europe until 1891, when he was appointed the first Da Costa professor of biology (after 1895, of zoölogy) at Columbia University. Here he organized the biology department and established the Columbia University Biological Series, of which he edited the first ten volumes.

In 1891 he was also appointed curator of vertebrate palæntology at the American Museum of Natural History. During the twenty years of his active administration he brought together a collection of vertebrate fossils that is remarkable not only for being the largest in the world, and for being prepared in the most skillful and instructive manner, but also for the richness of some of its series—that of the horse, for example, being practically complete from early Tertiary times down to living forms of to-day. In 1910 he retired from active teaching and administration to devote himself to research.

Prof. Osborn's contributions to knowledge are chiefly his collection of vast numbers of facts about the structure and distribution in space and time of vertebrate fossils, and his co-ordination of facts of palæontology in relation to the theory of evolution. He always insists that palæntology is a branch of biology, not of geology, to which it is joined only through the fortunate accident that fossils are found in the rocks. To mistake the position of fossils in the rocks, he says, "as indicative of their scientific affinities, is as logical as it would be to bracket Protozoa, which are principally aquatic organisms, under hydrology, or the Insecta, because of their aërial life, under meteorology." And he accordingly attempts to interpret the facts of palæntology in terms of organic evolution.

Among his earlier studies was that on the history of mammalian teeth, which have given the comparative anatomist and evolutionist a great deal of comfort as well as trouble. Teeth of primitive mammals, like the teeth of reptiles, have a crown consisting of a simple cone. The complex molars were believed by many odontologists and embryologists to have arisen by a process of "concrescence;" i. e., the simple teeth were supposed to have grown together in groups as the jaw-bones gradually became shorter, and formed the compound teeth, just as separate petals were supposed to be "fuzed together" in such flowers as the gentian or the pumpkin. Osborn, on the basis of mammalian fossils, early came to the conclusion that the complex molars of this class of animals have resulted from the successive addition of cusps to an originally simple tooth which attained a tri-tuberculate form during the Mesozoic period. As a result of further studies he found that with the exception of a few aberrant forms all orders of mammals have shown the tri-tuberculate type of molar teeth, and that the original cone has always been represented by the front cusp on the inner edge in the upper molars, and by the front cusp on the outer edge in the lower molars. He also found that the successively appearing new cusp always followed a definite order. On the one hand, he developed from these studies an exact descriptive nomenclature of the mammalian teeth which replaced the conflicting and confusing terminologies of earlier writers from the time of Owen; and on the other hand, he developed the theory of "determinate variation" in the evolution of organisms.

This idea, which he later renamed the doctrine of "rectigradation," he found to be practically identical with the "orthogenesis" of Eimer and other writers, and with the "mutations" of Waagen, and extended it to other structures. The cusps of the molar teeth do not appear "fortuitously" and then survive in accordance with their relative fitness, as would be required by the Darwinian theory, nor do they appear fully formed in a discontinuous manner, in the sense of DeVries's theory; they appear at definite points, at first too small to have any adaptive or selective value, and become with succeeding ages larger and larger until they are of adaptive value. In other words, they are *determinate* in their origins; they develop *gradually;* and they are *adaptive* in the direction of their development from the very start. In his earlier studies Osborn considered these facts favorable to the kinetogenic theory advanced by Ryder and Cope; that is practically the neo-Lamarckian view of the evolution of structures being directed by the habits and needs of the organisms. But later Osborn saw that of all the structures in the body the teeth are least



Osborn's modification of Weismann's germ-plasm diagram.

According to Osborn heredity, ontogeny, selection, and environment are inseparable in any discussion of evolution.

able to show any such influence because they are fully formed before they emerge from the gums and they cannot improve with use, on the contrary, the more they are used, the more they are worn away; whatever virtues or fitness the teeth of an individual may show are congenital. The rectigradations are thus not in themselves the result of selection nor of saltation, neither can they be accounted for on Lamarckian principles; they arise because of some inherent tendency or potentiality to vary in a determinate direction. What this internal determining factor is we do not know. It is not the same as Nägeli's "internal perfecting principle," since it operates in a direction parallel to ontogeny, that is, it causes evolution to proceed in adaptation to *new external conditions.* For example, certain Eocene monkeys had become herbivorous, and their teeth developed so much like the ungulate type that their fossils were at first classed with ungulates.

The same principle of hereditary ancestral control of variation was afterward found by Osborn to be illustrated by the origin of horns and other organs; and other workers found parallel facts in various series of fossils. The date at which characters develop is determined by external factors, but the nature of the characters is determined by internal factors, at present "unknown." Thus a comparison of Eocene horses with contemporary titanotheres shows that the horse was developing the cusps more rapidly; but both groups were developing the cusp in the same predetermined order. The law is illustrated also by the fact that similar characters have arisen simultaneously in groups of animals of common ancestry in Switzerland in Patagonia and in Wyoming. On the other hand, certain characters seem to be less firmly bound up with hereditary control. An example of this is the shape of the head, which Osborn found in a number of contemporary Mid-Eocene branches of titanotheres, of undoubtedly common ancestry, to show a tendency to diverge into narrow and broad-skulled types. In each diverging branch, however, once a tendency had established itself, the development proceeded to the limit without reversal.

From a study of fossil horses, in the course of which Osborn built up the history of this group in a very satisfactory manner, he passed to a thorough study of the titanotheres, which, of all extinct animals furnish the most complete series of fossils. Here his earlier generalizations have been amply confirmed, and the "unknown factors of evolution" are still there to be discovered. Instead of minimizing the difficulties unearthed by the palæntologists, Osborn thinks that scientific progress can be assured only if we frankly admit the limits of our knowledge in certain directions; he does not say we cannot know, but merely that here we do not know. A good summary of his evolution creed was given by him in his address before the Palæntological Section of the International Zoölogical Congress in 1907:

1. Many origins of new characters are due to some internal action in heredity.

2. Many important adaptive characters arise determinately, definitely and by extremely slow stages.

3. Degrees of similarity in such origins correspond to degrees of kinship.

4. Degrees of kinship also affect to a certain extent, but not absolutely, the time of appearance, or the time of the origin, or the rate of evolution.

5. The origins find expression not spontaneously, or irrespective of conditions, or from purely internal mechanical causes, but through some entirely unknown and at present inconceivable relation to ontogeny (habit and use) and to selection.

6. If such origins do spring from internal hereditary principles, as they appear to do in many cases, rapid origins (mutations of DeVries) may be simply due to the same law operating with a different velocity.

In all his discussions of evolution Prof. Osborn emphasizes the fact that the four recognized factors—heredity, ontogeny, environment and selection—are inseparable; and he criticises much of current debate because now one factor and now another is treated as if it acted uninfluenced by the others. He would modify Weismann's well-known diagram showing the continuous line to represent the germ-plasm, by placing the four factors in a series wherein each is shown as influencing all the others, and being in turn influenced by them. His philosophy attempts to harmonize the findings of the experimentalists, of the field naturalists, and of the palæontologists; the last, he says, have the best perspective, for they see the evolution of characters through long ages, without regard to particular organisms or species in which, for the time, they are perhaps being manifested.

Prof. Osborn's career is a splendid refutation of the prevailing cynical conception of "human nature," which can find no incentive to noble endeavor except in the pursuit of material gain guided by self-interest. And it also vindicates the "pure" scientist against the charge of impracticality and inefficiency; for every institution with which he has been connected shows the work of a master in efficient organization and administration.

Artificial Snails

SNAILS the only genuine part of which are the shells are now being sold in Paris, and it is said that the imitation of the real article is so close that many epicures have a high opinion of the sham product. But it is to be presumed that they do not know that the snails are artificial, and they are certainly ignorant of the method by which the snails are manufactured.

Snail-shells, it seems, are bought from the dustmen and rag-pickers, and after being cleaned are filled with "lights" or cats' meat, the soft flesh being cut into corkscrew form, so as to fit the shell, by a skilfully designed machine. The receptacle is then sealed by means of liquid fat, and the *escargot* is ready for the consumer. The secret came out in consequence of an action brought by a man employed at the snail-factory to recover damages for a finger mutilated by one of the machines. The artificial snails find a ready market.

The Latest of the Big Railway Terminals

The Chicago Terminus of a Leading Western System

IN our special railroad number of June 17th last, we gave a description of the largest railroad terminal in the world which is now being built by the New York Central Railroad Company on the site of the old Grand Central station, and we drew attention to the fact that at the present time one of the most marked activities of the big railroads is the great scale upon which they are reconstructing their terminal stations in large cities to accommodate the ever-increasing volume of traffic. The present article is devoted to one of the latest and most handsome terminal of this character, which has been built by the Chicago & Northwestern Railroad Company as the eastern terminus of their line in Chicago. The station has been built to conform to the general work of track elevation which has been carried out in that city and forms one of its most important modern improvements.

The main shed, 840 feet in length, containing 16 tracks.

The main building of the station is a simple and dignified steel-and-granite structure four stories in height which has been treated in the early Italian Renaissance style of architecture. The main entrance, on Madison Street, is through a lofty Doric portico, which is carried upon a colonnade of six granite columns, each seven feet in its largest diameter and 61 feet in height. Back of this colonnade is a vaulted vestibule which is 132 feet wide, 22 feet deep and 40 feet high, entrance to the vestibule being by three imposing arches. At each end of the vestibule broad granite stairways lead up to the main waiting room, which is on the track level floor. There are similar vestibules of more simple architectural treatment at the Canal and Clinton Street entrances. These vestibules lead directly to a large public area 200 feet by 92 feet, around which are ranged the ticket office, baggage room, and other essential accessories. At the center of this public space a grand stairway leads to the concourse of the main waiting room on the track floor.

The principal architectural feature of the station is the main waiting room, which is treated as a great Roman atrium, with a barrel-vault roof. The pilasters and the whole order, as high as the spring of the vault, are dull finished in light pink Tennessee marble. The columns are of Greek Cippolino marble, whose delicate green hue harmonizes agreeably with the bronze of the metal work which frames the glass between the pilasters. The vault is of ornamental tile construction, with richly ornamented ribs of terra cotta, whose color harmonizes agreeably with the marble of the walls. Excellent lighting effects are secured by two semi-elliptical windows 60 feet in diameter at each end of the vault, and ten circular lunettes, five on each side. The exterior walls of the station building are of gray Maine granite, and they are made continuous with the walls which inclose the train shed, the latter being of mottled gray brick, with granite trimmings. As the train shed walls rise to a height slightly greater than the roof of the train shed, they assist in giving to the entire station the external appearance of one huge building, and the total effect is enhanced by the dignified front façade, which rises to a height of 120 feet above Madison Street.

The inner vestibule.

Of equal importance to the station building is the train shed, which extends to a total length of 840 feet, and covers in the 16 tracks and 8 platforms which serve the station. The place of the great steel-and-glass arched roof, which formed the invariable covering of large train sheds built from ten to twenty years ago, is taken by what is known as the "Bush roof," this being the first of its kind erected in Chicago. In this type the roof structure is carried on lines of columns, placed down the center of each platform, and the curve of the roof over each pair of tracks is broken by two longitudinal slots, through which the locomotive smoke-stack discharges directly in the open air. The roofs are of steel and concrete, and wired-glass skylights give ample light to every part of the train shed.

The main entrance, portico columns 60 feet in height.

Main waiting room, a dignified classic interior.

THE LATEST OF THE LARGE PASSENGER TERMINALS

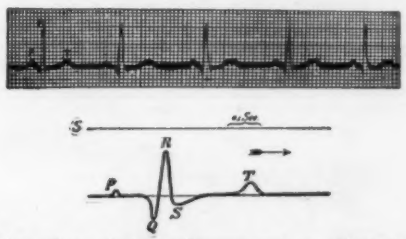
Heart Diagnosis by Electricity

By William Day

ONE of the most remarkable recent additions to the modern equipment for clinical diagnosis are the so-called "heart stations," now in operation at the Presbyterian and Mt. Sinai hospitals, in New York, and at the Johns Hopkins Hospital in Baltimore. The new apparatus represents the most refined diagnostic instrument at the service of the heart specialist, and not only enables him to follow with great certainty and clearness the specific features upon which his judgment of the case must be based, but it furthermore is capable of yielding data which would be quite unattainable either by the unaided human sense organs or with the aid of the ordinary instruments hitherto employed to extend somewhat the sensibilities of the organs of touch, sight and hearing.

The principle upon which the new method and apparatus are designed consists in the observation of certain electrical currents which accompany and are intimately related to the characteristic phases of the heart's action. The chief credit for the development of this method must be given to Waller, an Englishman, and especially to Einthoven, the noted Dutch physiologist. The latter it is who, in 1903, in his laboratory at Leyden, devised the so-called "string galvanometer," the most essential feature of the new apparatus. In most galvanometers the magnet is the movable part and the current to be measured passes through a stationary coil. In Einthoven's instrument this arrangement has been reversed; the magnet is stationary and the current passes through an extremely fine wire, measuring 0.001 to 0.003 millimeter in thickness. The filament may be of quartz covered with a fine silver coating to render it conducting, or it may consist of platinum. A very serviceable platinum thread would measure 35 millimeters in length, and from 2 to 4 micromes in diameter. This is about one-third to one-half the diameter of a red blood corpuscle. So delicate is the thread that it can be seen with the naked eye only when powerfully illuminated against a dark background. Such a thread is too light to be weighed upon even an extremely sensitive balance. Its weight has, however, been calculated by Einthoven to be about 3 to 7 thousandths of a milligramme. The ends of the thread are fixed, so that the thread is stretched and free to vibrate very much like the string of a musical instrument. This is the feature that has given the name "string galvanometer" to the device. The string is suspended midway between the pole pieces of a magnet, which is preferably an electromagnet. It operates on the principle that when an electric current is passed through a magnetic field, the conductor, if free to move, suffers a deflection perpendicular to the lines of force which pass between the poles of the magnet; thus when a current passes through the string of the Einthoven galvanometer this string is deflected to one side or the other, according to the direction in which the current passes. In order to obtain an accurate indication and record of the oscillations produced by the passage through the galvanometer of the feeble currents originating in the heart, a magnifying and photographically recording apparatus is provided. The cores and poles of the magnet are pierced through their centers, and two microscope tubes are inserted in the openings. One of these tubes is fitted with a lens for focusing a strong electric light upon the string; the other is a projection microscope which throws an enlarged image of the illuminated string upon the slit of the photographing apparatus, or else upon a white screen on which the movements of the thread can be observed directly by eye. Incidentally, it is interesting to note that a filament can be made from quartz dust by a special process. The threads so obtained are probably the finest ever made, measuring about 1/1,250 of an inch in diameter.

By the aid of this remarkable instrument the physician can see and record the oscillations which the string undergoes as the result of the electric currents generated in the human heart during its muscular excitation which precedes every beat. The rapidity of the string movements, their extent, and the regularity or irregularity of their rhythm reveal significant information regarding the condition of the heart muscle. And the remarkable thing about the method is that the diagnosis may be performed with the patient in a distant room or building, the necessary connection being established through a line of electric wiring.



Portion of an electrocardiogram and an enlarged section of the same showing the characteristic features of each cardiac cycle.

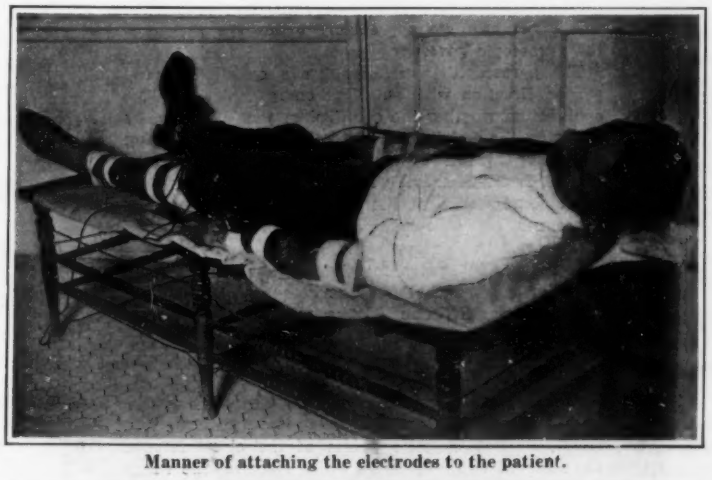
While the coarser features of the characteristic movement of the galvanometer string can be followed by eye, for purposes of obtaining an exact record of all the finer features it is necessary to resort to photographic registration. The magnified image of the string is projected by means of a powerful electric light upon a slit in a dark box containing a moving photographic film. Ordinarily a film of half the length of an ordinary Kodak film is sufficient for one observation. Occasionally, however, much longer photographic films may be employed. A lever connected with a chronometer marking fifths or tenths of a second oscillates before one end of the slit, so that a series of marks appears upon the film and clearly indicates the lapse of time corresponding to the several motions recorded upon the film. The record thus obtained is called "electrocardiogram."

One can, if desired, also record simultaneously on the same film a sphygmographic curve of the carotid pulse by placing before the slit a lever connected with a drum and receiver. But another expedient for this purpose is registration of the carotid pulse by means of a telephone and a second smaller galvanometer, the string of which is projected on the same slit. If desired, a third galvanometer may be used in connection with a microphone, and an electrophonographic record (or "cardiophonogram") of the heart sounds be made simultaneously with the electrocardiogram and carotid sphygmogram upon the film. This means that by the aid of the galvanometer and its auxiliaries, the conditions of the heart and arteries can be investigated simultaneously in at least three different ways: (1) As regards the electrical changes in the heart muscle, (2) as regards the pressure changes in the carotid artery, and (3) as regards the sounds produced in the heart during activity or while it is at rest. Yet, as stated, the patient, while the examination is being made, may be at a considerable distance from the heart station. Thus the electricity in the body of a patient in the hospital in Leyden, one and a half miles away, has revealed important facts regarding the condition of his heart to the physicians working in Einthoven's laboratory of physiology.

The apparatus in the heart station includes a whole series of different instruments, and is employed for the observation and recording of heart excitation and pulsation, heart sounds, pulse waves, blood-pressure, etc., with a view of determining if the heart is healthy or diseased; and the station is remarkable for the delicacy and compactness of the apparatus which is accomplishing such results in the aid of medical science.

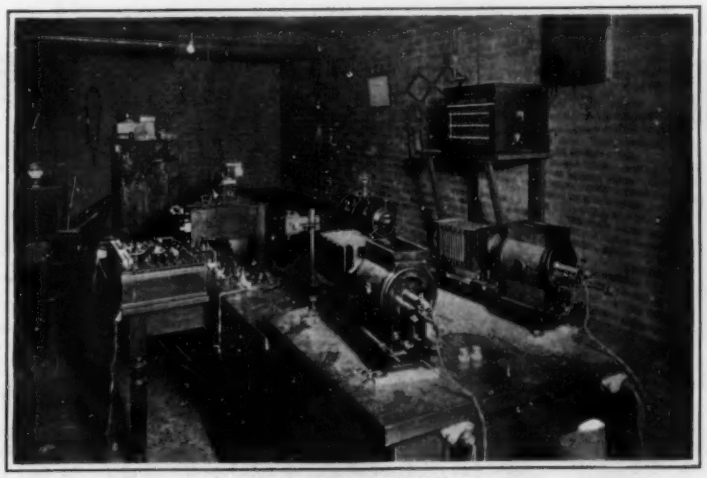
In operation the connection of the patient with the station is naturally of much importance, so that the current generated by the heart may be transmitted without loss if possible. The patient places left arm, left foot and right arm in three electrodes, which consist of zinc pans filled with normal salt solution of a strength of 8 grammes to the liter, or they may be made of German silver plates covered with felt and soaked in salt solution. From each of these, wires are conducted to three switches, by means of which any two of the electrodes can be connected to

(Continued on page 90.)



Manner of attaching the electrodes to the patient.

View of the apparatus at the heart station.



Details of the heart station.

In the foreground are two arc lights. On the second table is placed the large galvanometer, for taking electrocardiograms, and the small galvanometer for registering heart sounds. On the wall is a telephone switchboard with connections to wards. On the third table is the multiple switchboard for making the various connections of the electrocardiograph.

DIAGNOSING HEART DISEASES BY ELECTRICITY

Abstracts from Current Periodicals

Phases of Science as Other Editors See Them

Maintaining the Stability of Aeroplanes by Means of Gyroscopes

THERE are serious objections to the employment of gyroscopes for maintaining the stability of aeroplanes in the manner in which they are employed on the mono railway and in some experiments with nautical vessels. In order to utilize the peculiar property of the gyroscope on an aeroplane it must be used as Capt. Lucas-Girardville has used it to operate special stabilizing devices in the manner of an auxiliary motor. The principle of this application and the experiments made by Capt. Lucas-Girardville are described in a recent issue of *La Nature*, from which the following account is condensed:

If a gyroscope, with its axis of rotation initially in the line *OZ* (Fig. 1), its pivot at the point *O*, and entirely free to oscillate in all directions about this point, is acted on by a force which tends to turn the axis of rotation toward *OY*, the axis will resist the effort and will move toward *OX*, oscillating slightly to each side of the plane *ZOX*. This oscillation is called nutation. The value of the nutation is inversely proportional to the *vis viva* of rotation, and is therefore negligible for great angular velocities

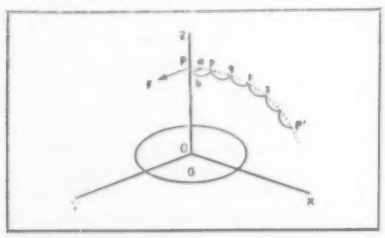


Fig. 1.—Principle of the gyroscope.

G, gyroscope; OX, OY, OZ, axes of rectangular co-ordinates; PF, deviating force; Pp', precession; ab, nutation.

of the gyroscope. The rotation of the gyroscope around *OY* toward *OX* is performed at a nearly constant rate. This movement, which is called precession, is utilized for the operation of rudders by means of which the equilibrium of the aeroplane is maintained.

The gyroscope is mounted in a carter which turns on two trunnions about an axis perpendicular to the axis of rotation. The line of the trunnions is parallel to the direction in which stabilization is sought. For example, if the line of the trunnions is parallel with the line of flight, any tendency of the aeroplane to pitch or rear will be counteracted by an elevating rudder operated by the reaction of the gyroscope. The motion may be communicated to the rudder by a cord passing around a pulley attached to one of the trunnions (Fig. 2).

The efficiency of this system has been shown by preliminary experiments in which the gyroscope and the rudder were mounted on an oscillating frame resembling the beam of a balance, the carter turning on an axis parallel to that of the beam (Fig. 3). The rudder was exposed to a uniform current of air produced by a blower, and the apparatus was adjusted so that it remained in equilibrium. In these conditions, if one end of the balance was depressed by the addition of a small weight or by touching it with the finger, the gyroscope, by means of a movement of precession about the axis of the carter, acted upon the rudder in a manner so that the pressure of the current of air upon the rudder restored the equilibrium. The apparatus was found to be so exceedingly sensitive that it was necessary to damp the oscillations by means of a plunger and a cylinder filled with water. Experiments performed with aeroplane models showed that even with only 130 square feet of sustaining surface the reaction of the air upon the aeroplane made the hydraulic brake unnecessary. It was demonstrated that in free flight an aeroplane

Fig. 2.—Gyroscope driven by flexible transmission from the motor.

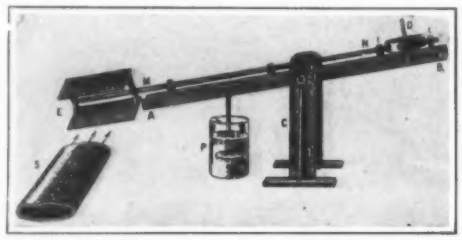


Fig. 3.—Experimental gyroscope balance.

AB, beam; C, support; D, gyroscope; tt, trunnions; E, rudder; MN, shaft of rudder; S, blower; P, hydraulic brake.

would not oscillate appreciably under the action of the gyroscopic governor.

The gyroscopic governors always operated in the proper direction with sufficient energy to restore the equilibrium whether the equilibrium was disturbed by changing the distribution of the load, or by employing irregular currents of air.

Capt. Lucas-Girardville is now engaged in constructing and adjusting, at the Military Aviation Park at Vincennes, an aeroplane equipped with gyroscopic stabilizers. In this apparatus a large bearing surface of nearly 1,100 square feet has been combined with remarkable strength by means of a special construction. The main frame is a vertical pyramid of bamboo, which forms the central support of a great circle made of steel tubes, attached to the frame by means of three systems of radiating steel wires (Fig. 4). This apparatus, which closely resembles an immense bicycle wheel 23 feet in diameter, is very strong and rigid. At two opposite points of the circumference are attached two projections which resemble the wings

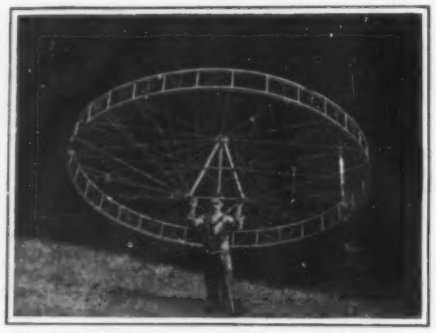


Fig. 4.—Circular frame of experimental aeroplane.

of an ordinary monoplane. The large circle and the two wings, covered with canvas, constitute the upper plane of a biplane, of which the lower plane is formed of a much smaller rectangular surface, the width of which exceeds its length (Figs. 5 and 6).

Two 70 horse-power Gnome motors of the new type are employed, placed in front of and behind the aeroplane in the line of motion. These two motors, which are independent of each other, rotate in opposite directions, in order to eliminate gyrostatic action in turning. One motor drives a right-handed, the other a left-handed screw propeller. Hence the two motors, with their propellers, assist each other, and if one breaks down the other allows the fall of the machine to be retarded and made more gentle.

The longitudinal stability of the apparatus is maintained by means of gyroscopes. In the first experiments the gyroscopes were driven by the motor by means of flexible transmissions and friction rollers, but this arrangement has been replaced by an aerodynamic system, in which the energy consumed by the gyroscopes is furnished by a small auxiliary propeller exposed to the wind produced by the main propellers.

The gyroscopes rotate at enormous speed, performing about 6,000 rotations per minute. As they are intended to assure longitudinal stability, they are so arranged that their movement of precession is performed about an axis parallel to the course of the aeroplane. In these conditions, when the machine tends to pitch or rear, the axis of the gyroscope turns to right or left and operates a rudder which restores the equilibrium.

No attempt is made to supersede the human pilot in the control of the elevating rudders. The object is simply to correct temporary instability or a mistake made by the pilot.

By employing two gyroscopes both longitudinal and lateral stability can thus be assured to a certain extent. One gyroscope, with its axis of precession longitudinal, would control auxiliary elevating rudders, while the other, with its axis of precession horizontal and perpendicular to the line of flight, would move ailerons or warp the principal planes. In this application of the gyroscope to maintaining the stability of aeroplanes, it must be remembered that the gyroscope acts indirectly by operating moving parts, the effect of which can be increased, diminished, or annihilated at will by the pilot, by means of similar organs under his own control. The gyroscopes do not exert any direct influence upon the aeroplane, because they are not rigidly attached to it.

The problem, indeed, is very different from that of the mono railway, in which it is required merely to prevent the car from falling over sidewise, while the rail maintains longitudinal stability by presenting a line of support which prevents the vehicle from pitching or rearing. A gyroscope, rigidly attached to the car, prevents the lateral overthrow of the vehicle by endeavoring to perform a movement of precession in a perpendicular direction, which is prevented by the presence of the rail. In a freely flying aeroplane such an apparatus would cause the vehicle to capsize.

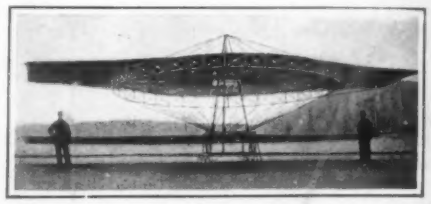


Fig. 5.—Experimental aeroplane in course of construction.

Lupus and Its Treatment

AMONG the bacterial diseases of the skin, lupus is characterized by its extraordinary prevalence and the production of very deep lesions, which permanently disfigure so many faces. In the scientific department of the Dresden International Hygiene Exposition the ravages of lupus are illustrated by a series of wax models which, according to *Hygieia*, show the social and economic importance of the diseases more convincingly than words could do. According to the statistics of the German Health Bureau, 11,354 cases of lupus have been treated by German physicians since November, 1908. More than two-thirds of the patients were women.

Lupus is treated in various ways. Volkmann's method consists in scraping the affected parts with a sharp spoon; Thiersch employs excision and transplantation; while Hollaender recommends treatment with hot air and with Roentgen and radium rays. The tuberculin treatment of Koch and Finsen's light

Fig. 6.—Experimental aeroplane nearly completed.

pp, automatic elevating rudder; P, elevating rudder operated by pilot; H, automatic steering rudders; LL, steering rudders operated by pilot; gg, gyroscopes; D, steering wheel.

cure are the most successful methods yet known. Finsen's celebrated institute was opened in Copenhagen in 1907. The great advantages of the Finsen method over others are that it is almost entirely painless and leaves no scars, except in places where the skin has already been destroyed. The apparatus employed by Finsen consists of a very powerful electric arc lamp of 30,000 to 40,000 candle-power, the rays of which are concentrated by quartz lenses. The radiant heat is largely absorbed by a water cooling device. As experiment has shown that the effective

rays are absorbed by the blood, and pressure is applied to keep blood from the surface. A hollow quartz lens, traversed by a continuous stream of cold water, is pressed firmly upon the diseased skin. The patient and the physician and attendants wear dark glasses to protect their eyes from the b inding light. Although the Finsen method is very successful, it suffers from the defect of requiring a long course of treatment which, in extensive development of the disease, may occupy many months, as only a fraction of a square inch can be treated each day.

A great advantage in this respect is possessed by Koch's tuberculin treatment, which rapidly dries up the pustules and checks the disease no matter how great its extent. The principle of the tuberculin treatment is the formation of protective bodies which kill the bacteria in the skin. The progress in the treatment of tuberculosis of the lungs has recently led to a new endeavor to combat lupus. Despite the progress that has been made, proper care for the unfortunate patients, whose disfigurement makes life a burden to them, demands the establishment of homes where they can find shelter and treatment. These homes could be partly supported by the work of the patients, according to their respective abilities.

The Great Waterfalls of the World in Their Relation to Industry and Conservation

THE waterfalls of the earth have become the subject of a conflict which is yearly increasing in violence. The lovers of nature wish to preserve the waterfalls in their original condition as far as possible for all time, while the engineers and industrial promoters seek to exploit them as sources of cheap power for electro-technical purposes. The accomplishment of this object on a large scale necessarily involves the total destruction or serious injury of the waterfalls, regarded as picturesque additions to the landscapes. It is only within recent years that waterfalls have been considered from the commercial point of view, but since it has been recognized that the energy of flowing water in very many cases furnishes a cheap and almost inexhaustible substitute for coal, which is yearly becoming more costly and more largely consumed, the great waterfalls which, as impediments to internal navigation, have hitherto been worse than worthless from the viewpoint of social economy, have suddenly become objects of very great value. The falling water drives the turbines of electrical power stations, producing electric light and power which, in many cases, is transmitted over hundreds and even thousands of miles. The war over the waterfalls which is now being waged by the friends of nature and the promoters of industry is likely soon to increase greatly in bitterness, for many celebrated falls have already been destroyed, or have at least suffered serious æsthetic injury, from the establishment of power stations. The famous Falls of the Rhine, at Schaffhausen, are at present the subject of heated controversy. Several power stations already stand on their banks and sap their life blood. The Swiss government, however, takes care to preserve a sufficiently large volume of water to maintain the character of the falls as a notable spectacle and an attraction for tourists. A still more bitter strife has been engendered in America by the question of the preservation or destruction of the Falls of Niagara. These famous falls have already narrowly escaped entire absorption in the pipes of power stations and very energetic action on the part of lawmakers, both in the United States and in Canada, has been required to keep intact from industrial invasion and preserve, in its original beauty, at least a remnant of this great wonder of the world.

Another North American waterfall which, as the highest fall in the whole world, especially deserves preservation as a natural monument, is apparently assured against destruction for all time. This is the Yosemite Fall in California, which makes a descent of 2,600 feet in three successive stages. As the whole Yosemite Valley, which was not discovered until 1851, was made a national park in 1864, the Falls of the Yosemite are under governmental protection and their pristine beauty can never be marred by the establishment of any power station.

There is a popular but erroneous impression, says Dr. Richard Herring in an article which is here reproduced from *Ueber Land und Meer*, that the Falls of Niagara are the greatest in the world, and even those more enlightened persons who know that the Victoria Falls of the Zambesi River in Africa are twice as broad and more than twice as high as those of Niagara, almost invariably assign to Niagara the second rank among the great waterfalls of the earth. Even this is an error, for South America possesses a waterfall which exceeds Niagara both in width and in height and is actually the second largest waterfall in the world. This little known waterfall is that of the Iguassu River, a tributary of the Parana, and like Niagara it is situated at the boundary of two States, each of which owns half of it. The total water power of the Iguassu Fall, which is 213 feet high and nearly two miles wide, is estimated as about fourteen million horse-power. This is approximately equal to the aggregate water power of all Scandinavia, which is so rich in waterfalls, or about ten times the total water power of Germany. The temptation to exploit this great, inexhaustible, never-freezing stream as a source of power for industrial purposes may easily be imagined. At present such exploitation is quite impossible, as the Iguassu Fall is too far from the beaten tracks of commerce to make it profitable to establish any electrical power station, but it will probably not be long before these falls will be threatened with the fate of Niagara. This undesirable possibility has been foreseen by the interested States, Brazil and Argentina, which have already begun negotiations designed to protect the falls.

The largest of the earth's waterfalls, the Victoria Falls of the Zambesi River, in Rhodesia, which are 386 feet high and more than a mile wide, and which were discovered by Livingstone in 1855, have also become the subject of a compromise between the conflicting demands of the lovers of nature and the promoters of industry. The water power of these falls is estimated to be fully thirty-five million horse-power, two and one-half times that of the Iguassu, and five times that of Niagara. By way of comparison, it should be noted that the aggregate water power of the whole of Europe cannot greatly exceed thirty-five million horse-power. It is certainly possible to derive a few million horse-power from this great fall without appreciably detracting from its majestic beauty. The demands which are made at present are still more modest. The Victoria Falls Power Company ask for only 150,000 horse-power, less than 1/200 part of the whole, and the plans for the future development of the station involve no danger of the annihilation of the falls. The British government and the colonists know very well that the Victoria Falls, which since 1905 have been easily reached by the Cape-to-Cairo Railway, which crosses the Zambesi immediately in front of the principal fall, will certainly bring as much money into the country by attracting tourists as by producing electrical power.

There is no other waterfall in the world which is at all comparable in greatness with the Zambesi, Iguassu, or the Niagara. Asia, notwithstanding its colossal mountain ranges, is comparatively poor in large waterfalls which are found most abundantly in Africa and North America. The largest African streams, especially, are interrupted by many falls of considerable height. The Congo has several high falls which, owing to the great volume of the river (about sixteen times that of the Nile), may be counted among the most important sources of water power on earth. The Stanley Falls, in the middle reach of the river, consist of seven successive falls, of a total height of 164 feet and a width of nearly 4,000 feet, and offer an exceedingly rich source of power which probably will soon be exploited. Still more important is the total water power which the Congo develops in the non-navigable section extending from its mouth to Stanley Pool. Here the river, confined in a channel only a few hundred yards wide, and with a depth of water of nearly 300 feet, flows with a velocity of 48 feet per second so that at every point of the stream 25,000 to 30,000 cubic meters, or about a million cubic feet, of water are hurled along with irresistible force, while thirty-two rapids and waterfalls lower the level of the stream by 820 feet in a stretch of 170 miles.

The lower Nile in Egypt possesses a series of rapids, the celebrated Cataracts of the Nile, but no waterfall in the strict sense of the word. True waterfalls occur on the upper Nile, the most beautiful of them at the point where the stream issues from Lake Victoria Nyanza. This Ripon fall is only a few yards in height, but the volume of water is so great that it presents a magnificent spectacle.

Comparatively few persons know which is the highest waterfall in Europe. The most voluminous of European waterfalls, strictly so called, are the Rhine Falls at Schaffhausen, but the highest are the Rjukan Falls of the Maan-Elf River, in the Norwegian province of Telemarken. The principal fall is 800 feet high and the total height of the two chief falls with the intervening rapids amounts to 1,837 feet, while the average flow of water is 50 cubic meters, or 1,760 cubic feet, per second. The largest water power station yet projected is here being developed by the Badische Anilin und Sodafabrik, in conjunction with other firms, for the fixation of atmospheric nitrogen. The Rjukan Falls, with their total energy of 250,000 horse-power, are already things of the past, for they have been irrevocably perverted to industrial uses. A similar fate threatens other small Norwegian falls, but Norway is so rich in waterfalls that it can well spare a few. In Sweden, likewise, the Falls of Trollhatta, the most celebrated of all Scandinavian waterfalls, have been almost entirely annihilated as objects of natural beauty. Nearly all of their water is now employed for the production of electricity. The government itself has recently established here a power station with a capacity of 40,000 horse-power. This, now the largest water power station in Europe, will soon be surpassed, however, by the station at Rjukan in Norway and by a still larger station in the north of Sweden, which will serve for the operation of the Lofoden Railway.

The Porjus Fall, at which this last-mentioned station will be placed, is only one fall, or rather rapid, of a long series formed by the Lule-Elf, near its source in the lake region of Lapland.

The largest and most beautiful of these falls is the celebrated Harsprang, which forms the subject of many legends. The Porjus power station is expected to reach completion in 1914 and to develop soon afterward about 80,000 horse-power, yet the wild beauty of the Porjus Fall will be little affected, as it is estimated that its total water power in summer, after its sources of supply have been regulated, will be about 300,000 horse-power. In the Porjus Rapid the river descends 164 feet in about 2 miles. The Harsprang is also half waterfall and half rapid and accomplishes a descent of 244 feet in 1¼ miles. The Harsprang would therefore yield more power than the Porjus, but it is to remain untouched for the present, and it is to be hoped that it will be forever preserved as a natural monument. Sweden, with its great wealth in water power, can well afford such a luxury. Even little Finland is endeavoring to preserve natural beauty and has decided to keep her greatest waterfall in its original condition as a natural monument, and to allow no large power station to be erected on its banks. This fall is the celebrated Imatra Fall of the Wuoxen River. The total descent is only 66 feet in two miles, but the volume is very great and the depth considerable, while the width of the stream contracts from 570 to 150 feet in the course of the falls.

Some Engineering and Economic Results of the Commercial Motor Vehicle.

THE *Engineering News* recently expressed the opinion that "The commercial motor vehicle must be able to show an all-around saving in the cost of doing a given task before it can expect to find favor as compared with the horse-drawn vehicle."

Further, it states, the motor-vehicle must make a very substantial saving over the simple, cheap horse-drawn vehicle in order to win success. Any motor-vehicle equipment is going to require a large investment compared with horses and wagons, and the purchaser must be shown a good profit on this investment after the items of depreciation and repairs are provided for.

"The average merchant, or manufacturer or contractor is not going to make a large investment in motor trucks or motor delivery wagons unless these vehicles can earn a good deal more than six per cent net on their first cost. Most concerns are borrowing money at that rate to use in their business."

At the present time however experience accumulated from many sources appears to show that there are commercial motor vehicles now on the market which can, under favorable circumstances, show a large saving over the cost of working with horse drawn vehicles.

The great advantage of the motor vehicle is that it can run at higher speed and carry heavier loads than any vehicle drawn by horses. Every engineer who has made an analytical study of the cost of wagon traffic knows that one of the largest items in the ton mile cost of freight haulage over common roads is the wages of the driver. It is an interesting fact that the lowest ton-mile costs for haulage by wagon over common roads in the United States are not made over the improved roads of the East. They are made in remote districts of the West, still beyond the reach of railways, where goods have to be hauled long distances over the crudest sort of highways and where the volume of traffic is such that teams of eight or a dozen or more mules are used to a load and one driver manages a load of several tons.

"It will be apparent from this that one of the most hopeful fields for the use of motor trucks is in any industry where the volume of traffic permits heavy loading and long hauls. The motor vehicle will make a better economic showing in heavy trucking, for example, than in light delivery wagon service. In the latter service, again, the advantage will be much greater if run on a suburban and country route, where distances are long and stops are few, than on a city route, where a small area is covered."

[The Editor of Handy Man's Workshop will be glad to receive any suggestions for this department and will pay for them, promptly, if available.]

A Simple Turnbuckle

By William Grotzinger.

A SIMPLE turnbuckle which I devised and used on my monoplane glider can be easily made as follows: Take the spokes and nuts out of an old bicycle

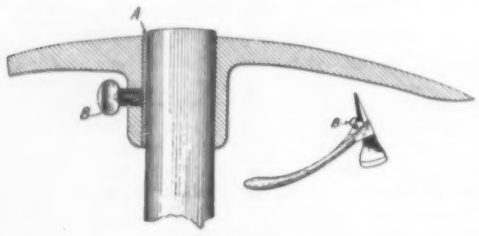
Turnbuckle made of a bicycle spoke.

wheel. Twist the wire at the unthreaded end, so as to form a loop to receive one end of the bracing wires. For the other end, cut a strip from a piece of sheet iron, 3 inches long and ¾ inch wide, punch a hole in the center to receive the threaded end of the wire. Punch a small hole at each end of the strip to receive the other end of the bracing wires. Now bend the strip as shown in the illustration, and put the nut in place. You will then have a small, neat, strong turnbuckle, which can be used for many purposes.

Adz-tightener

By W. A. Lane

AT its best, an adz is a rather dangerous tool to use, and to have it work loose is nearly certain to end in disaster. A tightener as shown here is not expensive, can be put on any adz, and will last as long as the adz itself. On the upper edge of the head drill a hole and tap for a ⅜-inch set-screw as



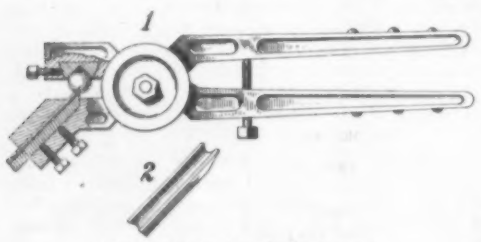
Adz-tightener.

shown in the drawing. Have the square head on the set-screw flattened like a thumb screw, so that you can tighten or loosen it with the claws of your hammer. Next, make a thin strip of iron the width and length of the upper side of the eye. The set-screw bears on this iron strip and makes the pressure on the handle even.

Turning Ball Joints to Gage

By C. G.

IN Handy Man's Workshop of April 1st, there was a description of a method of machining ball and socket joints. The writer is of the opinion that the tools used in the method described would be apt to



Device for turning balls to gage.

become dull in a comparatively short time, and then could not be sharpened without altering the gage. A friend of the writer recently designed the device shown in the accompanying sketch, which overcomes the difficulty. The cutting tool used is shown in perspective in Fig. 2. It will be observed that it consists of a bar with a channel in the upper surface which is of such shape that when the bar is cut off at an angle of 45 degrees, a cutting edge will be formed that will be a true semicircle. The tool is used in a device somewhat similar to a pair of pliers, as indicated in Fig. 1. In one of the jaws of the pliers is a bearing block with a pyramidal socket to receive the ball, while the cutting tool is mounted at an angle of 45 degrees in the other jaws of the pliers, with its cutting edge centrally disposed under the bearing block. With the shank of the ball end secured in the chuck of a lathe, the pliers are placed over the ball in the position indicated, and then the handles are pressed together until stopped by an adjusting screw, the tool in the meantime cutting the ball to standard gage. When the tool wears down, as will be the case after a few balls have been turned, it may readily be sharpened, provided the same angle is always preserved at the cutting edge.

An Improvised Bobbin Winder

By Henry H. Riggs

HAVING wasted much time winding small bobbins by hand for lack of a lathe, the last time I had to wind one it occurred to me to make use of a common drill brace, which proved so satisfactory as a bobbin winder that I pass the idea on to other amateur electricians whose outfit is limited as mine is.

The method is shown in the photograph. A drill shank or any bit of heavy wire will answer as a spindle to mount the spool on. If it does not fit the hole in the spool, wrap it with paper till it does, snugly.

Improvised bobbin winder.

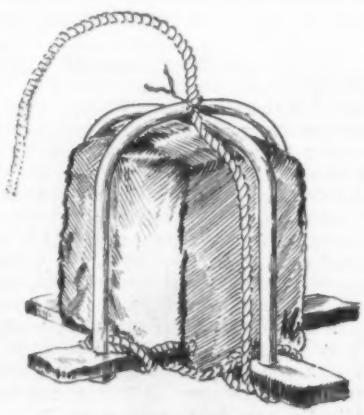
If a vise is not available, the brace can be clamped to the edge of the bench with a screw or two while the winding is being done.

A large spool of heavy wire can better be wound with a common carpenter's auger brace. The spindle on which the spool is slipped should be longer than the spool. The end is then supported by inserting it in a hole bored in the edge of the bench, while the butt end of the brace is supported in its traditional place in the "pit of the stomach." This leaves both hands free for winding.

Home-made Anchors

By Albert F. Bishop

HERE are two ideas that may be useful to the handy man who owns a boat, but doesn't own a suitable anchor. One of the illustrations shows an anchor of the conventional form, but made of wood and stone. A piece of wood with a natural bend is used for the fluke piece. The ends must be pointed and two holes must be bored through it, about 4½ inches apart, to receive two sticks of very hard wood. Each stick should have a knob on one end to keep it from drawing through the fluke piece. A stone should be placed between the sticks which may be sprung so as to em-



Anchor for a house boat.

brace the stone tightly. The sticks should then be well seized close to the stone and also at the upper ends. Anchor ropes are usually fastened to the fluke piece and thence pass up to the ring or loop, being seized there with a small cord. When pulling up the anchor this cord will break if the anchor is caught in the rocks. The rope will then capsize the anchor and probably release it. The writer saw this anchor on the bank of a river and thought it a very clever idea. The holding qualities looked very good.

The other anchor illustrated here is adapted particularly for houseboats. A cross of wood is made and holes are bored near the ends. A square weight is laid on the cross, and bows of hard wood are inserted in the holes and are drawn down tightly on the stone. The ends of the bows are well secured by means of hard-wood wedges. The rope is fastened to the cross

Wood and stone anchor for small craft.

and seized with a cord to the junction of the bows. This anchor was used by the captain of a small craft. He felt very secure when anchored with this home-made device.

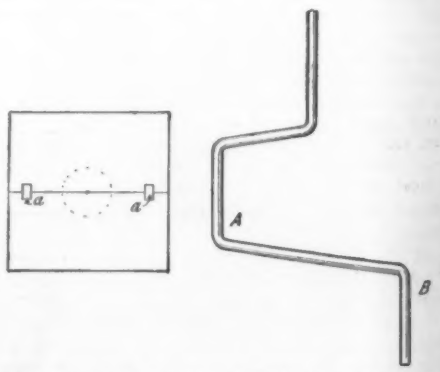
Making a Wooden Tube

By W. D. Graves

IN the days when iron pipe was more expensive than it now is, and wood cheaper, it was a common practice to bore logs lengthwise and to use them for carrying water underground, often for long distances. It was an easy matter to bore accurately in the center of logs because, in the kind of wood chosen for the purpose, a small open or pithy "heart" extended through it. This was very small, usually but little larger than a pin, but it was sufficient; for the worm of a bit found it to be "the line of least resistance" and would follow it. While this sort of wooden pipe is rarely to be desired, nowadays, it is sometimes desirable to have a wooden tube and to know how to make it. By making it in two parts one may arrange to guide the bit in much the same manner as did the old time aqueduct makers, and even more accurately.

These parts should be gotten out as shown in end view in the drawing, the two inserted tongues, *a*, *a*, serving to hold them relatively in place and to make the joint tight. Along what is intended for the center of the hole a deep gage mark is made, and, with a corner chisel or other tool, a small triangular section is removed for the whole length so that when the two parts are clamped together a small square hole will extend through where the center of the final hole is to be. The size this "pilot" hole should be depends upon the size of the bit or auger to be used. For a large auger it will not need to be more than an eighth of an inch square, and for a small bit the gage mark alone will often be found sufficient. It must be large enough so that the point of the worm will enter it, but small enough so that the bit will be firmly guided and drawn forward.

When boring the parts must be very firmly held together and the bit must be drawn out as often as the pod fills with shavings. For the latter reason it is advantageous to have a bit with as long a pod as



Blank for a wooden tube and double crank for auger.

is available. The shank of the bit is best lengthened by welding a steel rod to it. For turning it a common brace may be used; but if much work of this sort is to be done, it will be found to be accelerated by having the end of the rod bent into a double crank, like that commonly used on "ship augers," as illustrated. This is operated by taking hold at *A* and *B* with each hand. It requires a little practice to enable one to turn the cranks thus without making the bit wabble considerably; but as soon as one gets the knack he can do the work much faster than with a brace, and much more easily.

The Inventor's Department

Simple Patent Law: Patent Office News: Inventions New and Interesting

The Use of the Electro-magnetic Separator in City Refuse Disposal

THE magnetic separator is now largely used in various fields of industry, and is found to be of much efficiency in saving time and labor. It is employed to separate magnetic from non-magnetic material in a mixture of the two.

It is of value in handling coal, rock, and ore when it is essentia' that no large pieces of steel or iron should enter the crusher. It is also made use of for removing iron shot from molding sand, for separating brass chips from machine shop turnings, and for separating magnetic ores. This form of separator is also particularly useful in taking out the bits of iron or steel found in all sorts of junk, such as leather goods, rubber and rags, which must be removed before the material is worked over into new products, since if allowed to remain they would de eteriously affect the material or be a source of injury to the machinery.

Still another application is the use of the separator in grain elevators, cereal plants and flour mills. Before its installation much damage was caused to mill stones and other apparatus by the fragments of wire found in the grain as a result of the use of modern binders and reapers.

There are various more or less elaborate forms of separators, the simplest being the separator ro ler. The roller shown in the accompanying illustration consists of alternate coils and steel disks concentric with the shaft. The coils are wound on steel spools doweled to the disks, and the disks are in their turn keyed to the shaft.

Each coil is inclosed and protected by a cylindrical brass coil shield having a tight fit on each of the two adjacent poles. Current for the coils is obtained through carbon brushes held by self-adjusting holders on a pair of slip rings, at one end of the shaft.

These rollers are regularly built 12 inches in diameter, in lengths from 16 to 36 inches, and are driven by an electric motor mounted on the base of the machine. They have a current consumption of 325 to 750 watts, and capacities of 1,340 to 3,000 cubic feet per hour. They are designed to operate on any direct current voltage up to 250. They are usually installed as a part of a conveyer be t system.

The material falls from a hopper upon an endless moving belt below, and is carried along till it reaches the magnetized roller. The non-magnetic material being unattracted, is thrown off by centrifugal force to a bin or upon another conveyer belt, while the magnetic material attracted by the roller is held until it passes beyond the magnetic zone of the same on the under side, where it drops into another receptacle below.

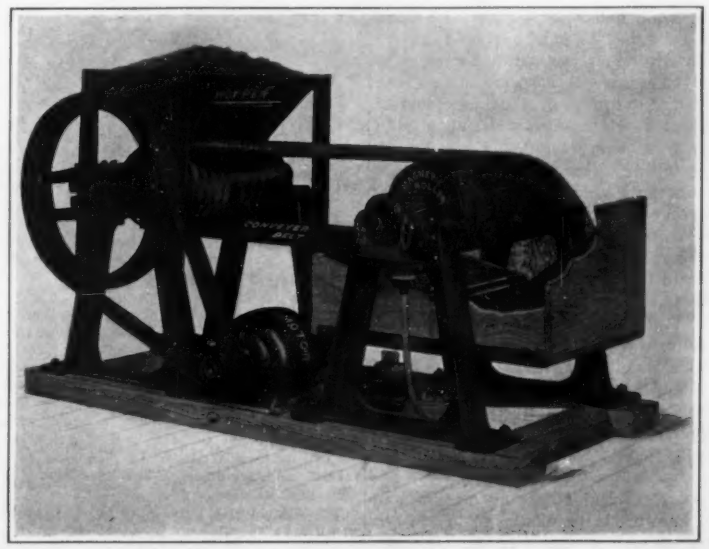
A novel and interesting application of this device is its use in garbage reduction plants. All city refuse contains a very considerable percentage of iron, chiefly in the form of metal cans, etc. It is very desirable to have this eliminated both because of its own value and to rid the other material of it.

The Borough of Richmond of the city of New York has recently installed a magnetic separator roller for this purpose, which has been running successfully for several weeks. It is believed to be the only one in the United States used for such a purpose, though several are in use in Great Britain. Mr. J. T. Featherstone, the superintendent of the Street Cleaning Department in Richmond Borough, gives some interesting data concerning the practical working of the separator.

The dimensions of the separator are 24 inches by 12, all the rollers being 12 inches in diameter. The cost of operation is very low, since one horse-power or less is sufficient to operate it, while the cost of the roller itself is not much over one hundred dollars.

About thirty tons of raw material daily are used. This is run through a furnace which melts it down into about twelve tons of clinkers, destroying at the same time the animal and vegetable matter. This, of course, is one of the main objects in city waste disposal, for sanitary reasons.

The clinker is then run through a crusher, and the resu'ting product passes onto a belt which carries it over the roller. On an average about 600 pounds of iron are recovered from the twelve tons of crushed clinker. The non-magnetic residue is used in the manufacture of concrete to take the place of broken stone and sand, and the process is especially valuable because the iron if allowed to remain would spoil the appearance of the concrete by a peculiar stain. It is probable that this process will be followed in other communities, when its simplicity and efficiency become known.



Magnetic separator.

A New Automobile Tire Pump

OUR illustration shows a new form of portable four-cylinder hand pump especially adapted for inflating automobile or motor-cycle tires. The aim which the inventor had in view in designing this pump was to provide a portable apparatus which could be readily attached to a suitable support such as the step of an automobile. The pump is furthermore so constructed as to combine great strength with simplicity of structure, so that it can be manufactured at a low cost, and is efficient and reliable in operation. The air passages are so formed as to avoid joints, which would be apt to become loose and to leak. With these objects in view the frame has been made in one single casting, consisting of a vertically disposed wall and cylinders integral therewith on opposite sides of the wall, the cylinders being disposed in axial alinement. Pistons reciprocate in these cylinders, being actuated by a handle *A* which is journaled centrally with respect to the cylinders in the central vertical plate; suitable valves *D* admit air to the cylinders for compression and permit the escape of the air when properly compressed.

A new automobile tire pump.

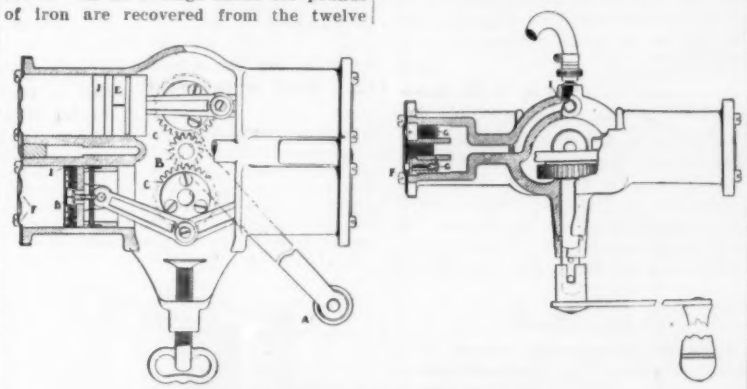


Diagram of the new automobile tire pump.

The passages for conveying the compressed air from the cylinders to the point of consumption are formed directly in the casting constituting the frame of the pump. Valves *G* are arranged in these passages for the purpose of preventing the return of the compressed air to the cylinders, and these valves as well as the intake valves *D* are so constructed that the use of ample lubricating oil in the cylinders will not result in the incomplete closure of the valves. The air inlet valves *D* are mounted upon each of the pistons and are automatically opened by suction by a friction-operated piston ring *E*, during the return stroke of the piston. All four cylinders are arranged in opposite pairs with separate head plates. A powerful screw clamp is formed integral with the cylinder casting by which means the pump is readily attached to the running board. The pistons are operated by means of pinions *C*, *C*, which have twice the number of teeth as the intermediate pinion *B*, so that the clamp motion is geared down to the ratio of two to one.

Each of the driving gear wheels is screwed to a crank shaft and from the crank pins, connecting rods secured to pistons on opposite cylinders. The two crank pins are arranged at right angles to each other, so that when one pair of pistons is at the end of the stroke the other pair is approximately at mid stroke. The gears are cut gears. The connecting rods are made of manganese bronze. The bore of the cylinders is 1¾ inches and the stroke 2 inches, equivalent to an 8-inch single stroke, and as the pump is so arranged that the compression strokes come at equal intervals, the pump is remarkably easy to operate, especially since the crank handle is quite long.

Notes for Inventors

The Money in Little Things.—The profits resulting from patents of limited scope frequently come to the notice of patent attorneys in active practice. The writer recalls an instance in which the patentee of a harvester knife grinder submitted the patent for an opinion as to its scope. When told that the patent was limited very closely to the structure it presented and that almost a "Chinese copy" would have to be made to infringe it he said "That may be so, but I have made seven thousand dollars out of that patent in the last three months in the territory west of the Mississippi." Possibly his wits had been sharpened by the grinding operation, for we recall an itinerant scissors grinder of the Irish persuasion who opened the office door one day and called out "Has yez anything to sharpen up to-day?" to which one of the office force replied, "No! unless you can sharpen up our wits," and the answer came quickly back, "I have no stones small enough for that."

The One Millionth Patent.—Patent number one million will issue shortly, probably about the middle of August. The first patent of the present series was issued July 28th, 1836, to John Ruggles (antedated July 13th, 1836) of Thomaston, Me., for a locomotive engine. One hundred and nine of the patents of the present issue were issued prior to January 1st, 1837, but these one hundred and nine patents were not regularly numbered on the patents themselves, although the original drawings and the specification in the Patent Office are regularly numbered. On January 1st, 1837, however, the patents began to be regularly numbered with patent one hundred and ten issued on that day, and the numbering has con-

tinued until the present time. It will thus require only a little over seventy-five years to complete the issue of one million patents. Prior to July 28th, 1836, 9,957 patents had been granted. These patents have never been officially numbered but were numbered in their order by Examiner-in-Chief Skinner when he was in charge of the classification division of the Patent Office. It has been suggested that some ceremony be attached to the delivery of the one millionth patent, but nothing definite along this line has as yet been decided.

A Woman's Patent.—Patent No. 838,053 should be of interest to women because it is for a combined bread toaster and warming oven for use on gas stoves. Apart from any particular interest in the invention itself, the patent is notable because it was issued to a woman inventor, Minnie Agnes Phelps of Chicago, prosecuted by a woman attorney of Chicago and witnessed by two women.

Storing Patent Assignments.—The necessity of fireproof storage facilities for the assignment records of the United States Patent Office was called to attention in our issue of May 27th. The Fire Marshal, P. W. Nicholson, of the District of Columbia has just submitted to the District Commissioners an extended report on the hazardous conditions existing practically throughout the Patent Office building. As to the general conditions in the Patent Office, the Fire Marshal has this to say:

"The worst conditions are on the third floor, 9th Street wing. The entire floor and corridors are taken up with combustible matter, wood shelving, filled with official documents. The corridor is used by the public in the examination of records and the position of the clerical forces is obstructed by desks and tables.

"There are two balconies extending from the floor to the ceiling filled with wood shelving, in which are stored official documents with small aisles hardly wide enough for one person to pass. The conditions are much congested. In the event of a fire the fire department would be much hampered by the obstructions from the corridors, besides encountering a regular wall of fire. The stairways are hidden from view by the wood shelving and are not properly located. There are two wire gates in this corridor, separating two different bureaus, that are kept locked at night. This should not be allowed."

Concerning the storage of gasoline in a manner prohibited by the District regulations, the report says:

"There is a small room in the basement, 7th Street wing, which is used for the storage of oils. I found in this room two wooden barrels, one containing kerosene and one containing gasoline. The manner in which gasoline is stored should be abolished at once, as it is very dangerous. A leak is liable to occur at any time, and if some person, not knowing the volatile conditions, should strike a match, a fire and probably an explosion would be the result. The regulations prohibit the storage of gasoline in this manner."

New Westinghouse Brakes.—A brake mechanism has been patented which has two winding drums. One of the drums takes up the slack in the chain and applies the brake shoes to the wheels, while the other drum applies the brake shoes to the wheels, with the maximum braking power. Means are provided which are operated at a predetermined degree of braking pressure to cut the first drum out of action. The patent, No. 994,286, was issued to the Westinghouse Air Brake Company as assignor of Richard C. Swartzwelder of Edgewood, Pa. In a patent, No. 994,220, Walter V. Turner of Edgewood, Pa., assignor to the Westinghouse Air Brake Company, provides an air brake in which a number of brake valves act in connection with a single equalizing discharge valve device for the train pipe, which is adapted to be operated by either brake valve, the brake valves having ports and connections so they can control the pressure in the equalizing chamber.

Caffeinless Coffee.—Three reissues, Nos. 13,261, 13,262 and 13,263, have been granted of original patent, No. 897,846, for the preparation or treatment of coffee in which the unbroken green coffee beans originally containing caffein, but freed therefrom, have their remaining natural constituents substantially unimpaired. In removing the caffein, the green coffee beans are treated with dry steam to loosen the molecular structure, then treated with gaseous chemicals to liberate the caffein from its salts, after which the caffein is extracted by a volatile solvent and the beans are subjected to currents of dry steam at different pressures.

The Cuspidors in the Patent Office.—Those who have visited the Patent Office will remember the large cuspidors that adorn the halls at intervals. It is told of a prominent Philadelphia lawyer of the old time that on one occasion he was sitting on the steps of the Patent Office nursing a lame foot. A Washington attorney asked what was the matter. He replied that he had been in and had a very unsatisfactory interview with a Patent Office examiner and it had been his habit when discussing patent matters before Congressional committees, if the results were unsatisfactory, to kick the rubber cuspidors then in use of the U. S. Capitol along the halls. On leaving the examiner's room after the unsatisfactory interview, he pursued the same tactics, thinking that the cuspidors in the Patent Office halls were also rubber, but he said with an exclamation: "I found them to be cast iron and almost broke my foot."

The Need of an Easily Set Rat Trap.—Wasn't it Jay Gould who laid the foundation of a great fortune by the sale of rat traps? If so, and you have ever tried to set one of these five or ten cent affairs they sell in the department stores, you may well wonder why some one does not follow his example with a mouse trap that can be set without losing all one's religion.

Ross Turner as a Patent Office Draftsman.—A celebrity who was at one time an *attaché* of the Patent Office is Mr. Ross Turner, the prominent water colorist. Prior to his European studies, Mr Turner was a draftsman in the draftsmen's division. This, of course, was many years ago, but Mr. Turner is well remembered by some of the older officials.

Legal Notes

Color and Trade-marks.—In *ex parte* Austin, Nichols & Co., the Commissioner of Patents has held, affirming the decision of the trade-mark examiner, that where the applicant states that the color of the trade-mark is not claimed, the special lining of the drawing to indicate color should be omitted. Also that coffee and cocoa are goods of the same descriptive properties.

An Unfair Competition Decision.—The Supreme Court of the United States by Mr. Justice Holmes has delivered an opinion in the unfair competition case of Jacobs vs. Beecham, affirming the decision below and holding that the burden rests upon the defendant when sued for an unfair use of the plaintiff's name to justify his use of the name; also that the use of the name of a manufacturer of pills under a secret formula upon pills made by a competitor is not saved from being unfair because the name of the manufacturer is accompanied by a statement that the competitor makes the pills, even if it be conceded that he is using the other's formula. The decision also refers to the use of the word "patent" as applied to proprietary medicines and holds that the use of the word "patent" to indicate a medicine made by a secret formula when the medicine is in fact not patented, is not such a fraud as defeats the right of the manufacturer to relief in equity against unfair competition. In the decision it is said: "The use of the word 'patent' to indicate medicines made by secret formulas is wide spread and well known. It is mentioned in the dictionaries and it occurs in the plaintiff's circulars."

RECENTLY PATENTED INVENTIONS.

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel.

HAT.—D. STERN, New York, N. Y. This invention relates to hats, and it has for its object the provision of one having a separate crown member, which may be readily mounted on a brim member, so that hats of many different styles may be quickly provided by the selection of the desired crown member, to be used with the brim member which has been previously selected.

Electrical Devices.

SIGNALING DEVICE FOR TELEPHONE SYSTEMS.—A. J. DUNTON, Ketchikan, Alaska. The main object here is to provide a signaling system in which the signals may be sent to a considerable distance, as far as the line is likely to be used for talking purposes. A further object is to provide a system with simple apparatus, including a relay for producing audible signals.

Of Interest to Farmers.

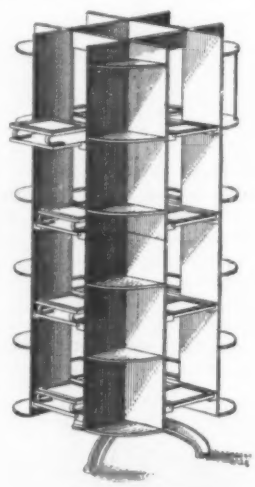
SAFETY CHECK FOR CUTTER BARS OF MOWING MACHINES.—N. ROGERS, Wolfboro, N. H. The object of this inventor is to provide novel means for automatically and instantly stopping the action of the cutter bar while the mowing machine is progressively moved, at the time the driver vacates the seat on the machine when said vacation is effected purposely or accidentally.

Of General Interest.

MARKING STAKE.—M. F. NOURSE, Cement, Wash. The intention of this invention is to provide a stake having a weight near its pointed end for steadying the stake, and so arranged that it cannot slip on the stake, even should it become loosened. A further object is to provide an improved holding means for the stake when not in use, with which the stakes may be easily connected and disconnected.

PACKER FOR WELLS.—A. C. GRAHAM, Oilfields, Cal.—One object here is to provide a packer which may be inserted within the casing already in position and which is left in place in the casing after the insertion of the cementing material. The cementing material will firmly lock the packer in place, and the lowering device may be disconnected from the packer without disarranging it in its position at the end of the casing.

DISPLAY STAND.—WALTER GILBERT, St. Louis, Mo. Among the principal objects which the present invention has in view are: To provide a revolving stand arranged and constructed to facilitate the handling and display of merchandise packed in cartons; to provide a simple and efficient means for delivering the cartons so that the same may be handled for the delivery of the goods therein contained; and to provide a display stand the construction of which is simple, economical, durable, and efficient. The illustration herewith, shows a perspective view of a vertically disposed rotary stand constructed and arranged in accordance with the invention described.



DISPLAY STAND.

TRUSS.—P. S. HAEHN, Youngsville, Pa. In this invention the construction confers resilient support for single or double ruptures in the inguinal region, adapts the truss for yielding conformity in the movements of the body, avoids excessive pressure upon the tissue near the rupture, but exerts such a constructing pressure upon the defining wall of the hernia as will have a tendency to close the edges thereof and facilitate a healing action that will cure the same.

LOADING WIRE FOR TRAVELER DISPENSERS.—J. S. DRAKE, Lancaster, S. C. The object here is to provide means for supplying travelers to the dispensing device, by means

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PATENTS

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FOR SALE.—I have invented a lead ring for cattle. Patent No. 1,986. I desire to sell this patent. For full particulars about this invention and other information, address, E. P. Williams, Route 3. Burlington, Kansas.

FOR SALE.—Patent No. 991,789. This is a joint-fastener. "Invisible" for window screens, screen doors, etc. No nails or screws used. D. A. Wright, 338 4th St., San Antonio, Tex.

THE PATENTEE of No. 986,733, a metal device for holding paper targets, especially useful for indoor practice, wishes to have same manufactured, or will sell patent or invest it in a factory. C. P. Worrell, Zanesville, Ohio.

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Inquiry No. 9256. Wanted addresses of parties having Pitchblende deposits, if able to ship ore.

Inquiry No. 9257. Wanted addresses of firms selling second-hand water turbines.

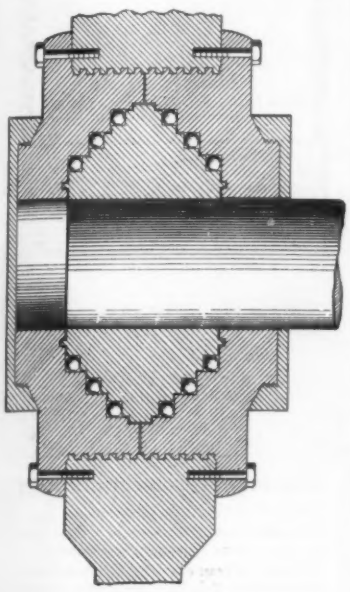
Inquiry No. 9258.—Wanted addresses of parties having gem materials to offer in any part of the world.

Inquiry No. 9259.—Wanted to buy a machine for removing the coating of a filbert.

Inquiry No. 9260.—Want addresses of parties able to ship corundum, garnet, flint, emery or any material suitable as an abrasive.

of which the travelers will be held in proper position for dispensing, and supplied to the device in such position. With the improved loading wire, the travelers may be placed on the magazine in proper position for dispensing, and they cannot become disarranged during transfer, neither can they be lost from the wire, if the pins are retained in place, until the loading wire is centered.

ROLLER BEARING.—LUTHER BADGER, St. Johns, Ore. This roller bearing is designed for general purposes, as, for example, car, locomotive, automobile and other vehicle wheels, and also machines of various characters. The invention is shown in the engraving which represents a central longitudinal section of the bearing, and the improvement contemplates an anti-friction bearing capable



ROLLER BEARING.

of free working under end thrust in either direction or a lateral strain, as that occasioned by the weight of the load, the bearing consisting of an inner and outer bearing member, and an internally threaded bearing support, the inner bearing member increasing in diameter in passing from the ends toward the center and the outer bearing member composed of two sections threaded into the bearing support from the opposite sides thereof.

Hardware and Tools.

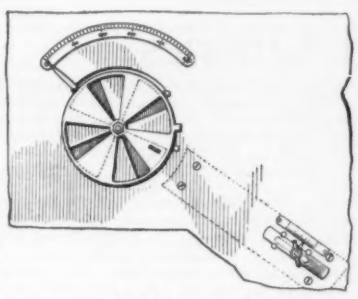
WRENCH.—CHARLES KANE, National Military Home, Tenn. This wrench is provided with different sized jaws, any one of which can be readily moved into active position and securely locked therein. Use is made of a jaw head mounted to turn on the end of the wrench handle and having a plurality of integral jaws of different sizes, and a bolt slidable lengthwise on the handle and

WRENCH.

having its outer end reduced in step form to engage and fit any one of the jaws, to hold the jaw head against turning in either direction on the handle. The engraving shows a plan view of the wrench having two jaw heads. It is all steel and durable, the jaws and locking bars are tempered cold steel and contain neither rivets nor threaded screws in the locking parts. The revolving jaws respond readily to the movement of the push button, and the angle at which the head locks, enables an operator to reach nuts or bolt heads in narrow and intricate spaces.

Heating and Lighting.

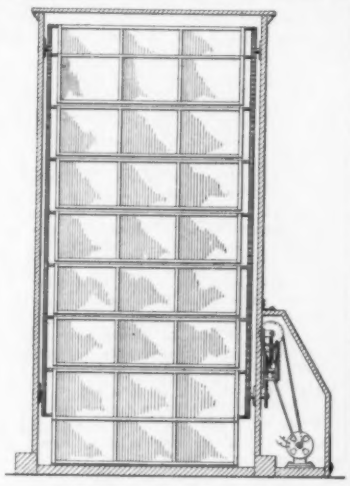
OVEN THERMOMETER AND VENTILATOR.—HENRY C. FERBRACHE, Bonners Ferry, Idaho. This device will automatically regulate the draft of an oven, whereby to maintain a predetermined temperature, will indicate the temperature and may be regulated to operate at different temperatures. The engraving shows a front view of a portion of the oven, with the improvement in place. Superposed strips and damper are so arranged that between certain predetermined temperatures, the damper is not affected. When, however, heat exceeds predetermined high temperature, the damper is closed, the composite bar being flexed toward the lamina having the lowest coefficient of expansion. As soon as the damper is closed, temperature rises, and the damper again gradually opens and is held open until the high temperature falls. When the damper is open or closed, some little variation in temperature is permitted before the damper operating mechanism again comes into play.



OVEN THERMOMETER AND VENTILATOR.

Machines and Mechanical Devices.

PICTURE DISPLAY CABINET.—MARK C. PHILLIPS, State Agricultural College, Corvallis, Ore. Among the principal objects which this invention has in view are: To provide an automatic mechanism to expose successively pictorial exhibits to attract attention and to

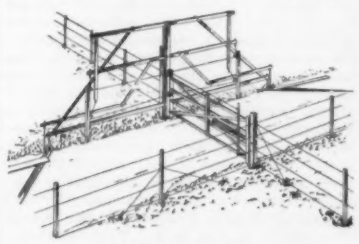


PICTURE DISPLAY CABINET.

please passers by; and to provide a flashlight mechanism for periodically illuminating the said exhibits. The illustration shows a vertical longitudinal section of a machine which in operation gives an attractive and continuously interrupted display of pictorial designs, interspersed with entertaining advertising matter.

RAZOR STROPPING MACHINE.—A. FORNANDER, New York, N. Y. This machine may be operated alternately by motor or manual power. The blade is addressed in approved position to the stropping member; the blade is oscillated to present opposite sides thereof to the stropping member; the stropping device has a continuously moving double belt adapted to receive there between the blade to be stropped; the double and face butted stropping member is arranged to receive between the faces thereof the blade to be stropped; the device holds the blade in inclined position when stropped, and means provide for varying the belt tension.

AUTOMATIC GATE.—LOUIS A. LAAS, Maxwell, Texas. This invention relates to automatic gates, and more particularly to gates that are unlatched and opened by a vehicle approaching along the road and closed and latched again through the same agency, all of which is done automatically. An object is to avoid encumbering the swinging gate



AUTOMATIC GATE.

itself with many or heavy operating parts. The gates is shown in the accompanying engraving, which pictures the various features of the construction, among which is the provision at each side of the swinging gate of separate vehicle-engaged road members, preferably in the nature of fulcrumed running boards, and located at opposite sides of the road, one of which controls the opening and the other the closing of the gate

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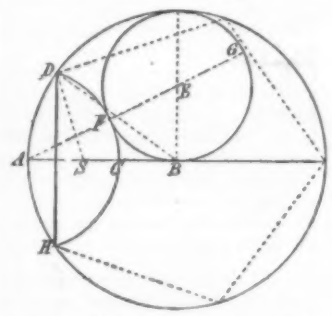
(12493) A. E. S. asks: 1. Can you inform your subscribers the degree of coefficient of expansion and the malleability of copper, brass, aluminium, soft iron, and steel? A. The coefficients of linear expansion for the metals you name are per degree Fahrenheit, and at a temperature of 104 deg. Fahrenheit, as follows: Copper, 0.00000610; brass, cast, 0.00001041; brass wire, 0.00001072; aluminium, 0.00001285; soft iron, 0.00000672; annealed steel, 0.00000607. No figures regarding malleability are reliable unless the condition of the sample is carefully determined. The general order of the pure metals in malleability, as given by Kent, is gold, silver, aluminium, copper, tin, lead, zinc, platinum, iron. 2. What is the metal or alloy having the nearest coefficient to glass? A. Platinum is the only metal which has the same coefficient of expansion as glass.

(12494) A. W. K. asks: Has anyone any experimental knowledge of a substance which, if shaped like a wedge, will weigh more when lying on its side than when lying on its back with the edge up? The writer firmly believes this to be possible, and that the heaviest substance is most likely to exhibit this phenomenon. A. We can answer your question that a wedge will weigh less when standing upon its head than when lying on its face, since in the former position its center of gravity is farther from the center of the earth than when it is on its face. It would require most delicate balances to show this in any piece of metal which such balances can weigh correctly.

(12495) F. R. S. says: I was interested in a method given in query 12456 for inscribing a hexagon in a circle, and hereby submit a geometrical solution for same. It is only a combination of two problems in the ordinary text books. I thought the solution might be of interest to your readers.



A. Theorem: Line HB is side of inscribed pentagon. Proof: First, to prove that AC is a mean ratio between AB and BC or

$$AB : AC :: AC : CB$$

$$\overline{AB}^2 = \overline{AE}^2 - \overline{EB}^2$$
$$= (AF + FE)^2 - \overline{EB}^2$$
$$= (AF + EB)^2 - \overline{EB}^2$$
$$= \overline{AF}^2 + 2AF \times EB$$
$$= AF(AF + 2EB)$$
$$AC(AF + FG) =$$
$$AC(AC + AB) \text{ since}$$
$$BE = \frac{AB}{2} \text{ (construction)}$$
$$= \overline{AC}^2 + AC \times AB$$
$$\therefore \overline{AB}^2 - AC \times AB = \overline{AC}^2$$
$$\therefore AB(AB - AC) = \overline{AC}^2$$
$$\therefore AB \times CB = \overline{AC}^2 \text{ or}$$
$$\frac{AB}{AC} = \frac{AC}{CB} \therefore AB : AC :: AC : CB$$

Make $AS = CB \therefore SB = AC$

Now, from above:— $AB : BS :: BS : AS$ by construction and $AD = AC$ by construction.

$\therefore AB : AD :: AD : AS$, hence $\triangle s\, BAD$ and SDA are *similar*, but $\triangle\, BAD$ is isosceles $\therefore \triangle\, SDA$ is isosceles and $AD = DS = SB = AC$. $\therefore \triangle\, SDB$ is isosceles and $\angle DBA = \angle ADS$, but $\angle DSA = \angle DBA + BDS = 2DBA$. Hence $\angle DSA = 2DBA \therefore$ Sum $\angle s$ of $\triangle\, ABD = 5 \times \angle ABD = 2rt.$, $\angle s$ and $> ABD = \frac{1}{2}$ of $2rt.$, $\angle s$ or $\frac{1}{10}$ of $4rt.$, $\angle s \therefore$ are $AD = \frac{1}{10}$ of a circumference or are DAH is $\frac{1}{5}$ *of a circumference!* Q. E. D.

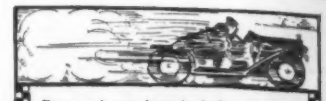
(12496) G. O. B. says: Your answer to query No. 12467 in your June 10th issue interested me greatly. I want to ask: 1. If the rise in temperature of air during compression is due to the more frequent collisions of the molecules? A. The compression of a gas is the effect of a mechanical force against the outward pressure due to the heat energy of the gas, which varies with its temperature. The result of the compression is to bring the molecules nearer together and produce more collisions per second by reducing the mean free path through which a molecule can move before it collides with another molecule. The outward pressure is increased, and the collisions are both more numerous and more violent. The temperature is raised for both reasons. 2. What is the cause of the drop in temperature upon the air being released from pressure? A. The opposite action, namely, expansion, produces the opposite effect, namely, a drop in temperature. The distances between molecules are increased, the mean free path is lengthened, and the number of collisions is reduced.

(12497) O. W. E. asks: Would you kindly tell me where I could get some information regarding "colloidal solutions," or a finely divided metal in a liquid? I am particularly interested in copper. If you have any SUPPLEMENTS containing anything on this subject, kindly tell me what they are. A. You will find valuable articles upon colloidal solutions in the SUPPLEMENT Nos. 1477, 1581, 1779, 1804, price ten cents each. The subject is treated in all the physical chemistries. We can send you Jones's "Physical Chemistry" for $4; also Zsigmondy's "Colloids and the Ultramicroscope," price $3.

(12498) J. S. R. asks: 1. I would like to know if there is any substance of any kind that smoke will dissolve or act on in any way. A. Smoke is a mixture, differing with the fuel which is burned, and with the incompleteness of the combustion. The black portion which we usually call the smoke is simply the unconsumed carbon drifting away. This cannot dissolve anything. The gases from the combustion are able to act upon many materials and corrode them. There is also much hot-water vapor in smoke, which becomes water when it is cooled and aids the rusting of iron or corrosion of other metals upon which it may be condensed. 2. Is mercury a conductor of electricity, or anything in liquid form that is? A. Mercury is a conductor of electricity, as also are all solutions of metallic salts, such as copper sulphate and common table salt, and most acids mixed with water. There are thus a great many liquid conductors.

(12499) H. O. S. says: Regarding the sounds given forth by the reproducer of a talking machine, the manager of the record department of one of the priacipal companies asserts that during a band selection all the instruments playing at one instant are given forth by the producer at one instant or at the same time. Now will you kindly answer this: Is it not a fact that any object giving forth different tones by vibration can have but one rate of vibration, with its accompanying tone, at any one instant or fraction of a second, it being impossible for it to vibrate at two different rates at the same instant? I have always understood and believed this to be so, and it seems to me to disprove the record department manager's assertion. Taking the length of the record groove passed over by the reproducer during one second, my opinion is that there is but one sound at any one time; but as there is one sound each smallest fraction of the second, and they follow each other so swiftly, the ear cannot comprehend that it is being deceived, and believes it hears more than one instrument at the same time. Could not this be positively ascertained by having two trombones or cornets play each a different sustained note, and see if the reproducer would give the two tones together? Or perhaps two different notes on an organ would be more mechanically exact and even. A. It is not a fact that any object giving forth different tones by vibration can have but one rate of vibration with its accompanying tone at any one instant or fraction of a second. It is very possible for it to vibrate at two different rates at the same time. The difference in tone quality of different voices and instruments is due to this very fact, and a vibrating string of piano or violin vibrates at a large number of rates at the same time. The recorder of a talking machine takes a form of motion due to the resultant of all the forms of motion which it receives from the sounding instruments, and for this reason the record can impress upon the reproducer the same tones as it has received from the motion of the recorder. Doppler's Principle is the accepted explanation of this fact. Many tracings of combined tones have been made. It is of course very difficult, if not impossible, to extend such records to the very complicated resultants of the impressed curve of the disk of a talking machine for an orchestra, but the fact that this is true of simpler compositions of tone leads with certainty to the belief that it is also true of the complex tones of the band or orchestra. We do not look for any change in the accepted theory on the matter. The opinion of the manager of the record department which you quote is entirely in accord with our own.

(12500) J. W. N. asks: Under the rules of science, as taught by the institutions of the world, is it possible for any man or agency to forecast the weather for months



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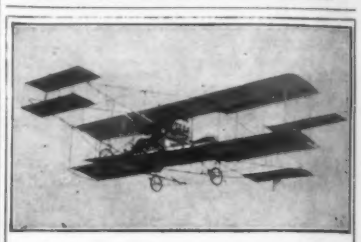

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ahead, as is done by a few self-asserted prophets and so-called weather bureaus of this country? A. It is not possible to foretell the weather for any extended period, beyond the most general terms. The U. S. Weather Bureau after more than forty years of continuous practice does not attempt specific predictions for more than thirty-six hours. Long-range forecasting is not yet reliable. The conditions which determine the motions of the vast masses of the atmosphere are too little known. When a storm appears in our western region, it is not possible to tell at what point it will leave the Atlantic coast, or what its path will be across the country. The success of the U. S. Weather Bureau in forecasting storms, frosts, and river floods is very remarkable, and this work of the Bureau is worth many times its cost, but these men are very careful to disclaim the ability to predict the weather for any specified place for any extended period.

NEW BOOKS, ETC.

THE SHIPPING WORLD YEAR BOOK. A Desk Manual in Trade, Commerce, and Navigation. Edited by Evan Rowland Jones. London: The Shipping World Offices, 1911. 8vo.; 1755 pp.

The twenty-fifth edition of this well-known annual is bigger and better than ever before. Scarcely anything of value coming within its scope has been omitted. The new tariffs of Austria-Hungary, Bulgaria, France, Japan, The Netherlands, Sweden, and Greece are given. There is a complete port and harbor directory of the British Isles and a directory of all the commercial ports of the world, with particulars as to accommodations, charges, tides, trades, pilotage and towage, revised up to the hour of printing. Among new features of the edition may be mentioned the tables of freeboard, a digest of the merchant shipping Acts from 1894 to 1909, tables of foreign money, weights and measures, with English equivalents, foreign trade statistics for 1910, details of the world's shipbuilding output for the past year, and a mass of invaluable information which the exhaustive index makes easily available. A new map of the world, especially prepared by J. G. Bartholomew, F. R. G. S., folds into a pocket at the back of the volume. This shows the routes of steamers and railways throughout the world, and the products, ports, coaling stations and coal fields of all countries.

ARGENTINA AND HER PEOPLE OF TO-DAY. By Nevin O. Winter. Boston: L. C. Page & Co., 1911. 8vo.; 421 pp.; illustrated. Price, $3.

Argentina, like the other countries of South America, has received far less consideration than it is entitled to. One of the greatest food-producing countries of the globe, queen of the South American republics, first among them all in import and export trade, with a capital ranking as one of the greatest cities of the world, Argentina must quicken the pulse of all who are attracted by the new, the progressive, the resourceful, and the ambitious. We have in the volume before us, to use the author's own designation, "an account of the customs, characteristics, amusements, history and advancement of the Argentinians, and the development and resources of their country." It is a brightly-written and well-made volume enriched by charming views and illustrations.

NORTH DEVON WITH WEST SOMERSET. By Beatrice and Gordon Home. New York: Frederick Warne & Co. 12mo.; 220 pp.; illustrated.

This is a little volume to fit the pocket, containing some very good views of the countryside, coast scenery, and picturesque buildings. The part of England with which it deals has an exceptional and distinctive beauty, as everyone knows. Such names as Covelly, Ilfracombe, and Exmoor conjure up pictures of appealing quaintness, glimpses of rugged promontories and far-flung bays lying in purplish light, and stretches of wild moor and wild-blown spaces. We are now in the land of Lorna Doone and her "girt Jan Ridd." The book is not a stereotyped guide, although its large-scale maps slight nothing, but is almost like a gift-book in style and make-up—would, indeed, admirably serve that purpose—and is full of sympathetic description and discriminating illustration.

HOMESTEAD. The Households of a Mill Town. By Margaret F. Byington. New York: Charities Publication Committee, 1910. 8vo.; 292 pp. Price, $1.50; postage, 20 cents.

Homestead is a town. Homestead is also the mill which perpetuates the town. But Margaret Byington's book is mainly of the home life the mill town leads on the wages which the mill pays. It is a community of working men, representing an early Teuton-Celtic wave of immigration and a later Slavic influx. Perhaps the main interest of the survey centers on "life at $1.65 a day." We are not so much drawn to a study of middle-class living and humdrum respectability. Our literature must give us either the prince or the pauper—either Brewster's millions or the widow's mite. These nine-dollars-a-week men with wives and families can allow themselves but twenty-two cents per man for a day's food. The Committee on Trade and Commerce estimated that in Pittsburgh a liberal provision of food for a family of five could not be purchased for less than $11.88 per week. From these contrasting figures we may draw our own conclusions as to the unenviable state of the unskilled worker in the steel mills. Rents are high. The twelve-hour day, continued in many cases through the seven days of the week, leaves no time for anything else save food, a pipeful of consolation, and sleep. This is of course the shadow of the picture, there are higher lights. The volume is one of the six which comprise the notable Pittsburgh Survey findings, and is remarkable for the way in which it goes to the very heart of things and tabulates human strivings, longings, and limitations in columns of cold type.

THE CHEMISTRY OF THE COAL TAR DYES. By Irving W. Fay, Ph.D. New York: D. Van Nostrand Company, 1911. 467 pp. Price, $4 net.

The book gives a good presentation in concise form of the principal classes of organic dyestuffs. An idea of its contents and their arrangement may be obtained from the chapter headings, which are as follows: 1. Introduction; 2, Coal Tar and Its Products; 3 and 4. The Hydrocarbons and their Derivatives. 5. The Nitro and Nitroso Dyes. 6. The Triphenylmethane Dyes. 7. The Classification of the Coal-Tar Dyes. 8. The Azo Dyes. 9. The Seven Food Colors. (Devoted to the seven dyes whose use in foods and beverages has been sanctioned by the U. S. Government). 10. The Pyronines. 11. The Indamines, Indophenols, Thiazines, Oxazines. 12. The Eurhodines and Safranines. 13. The Quinoxaline, Quinoline, and Acridine Dyes. 14. Aniline Black. 15. The Alizarine Dyestuffs. 16. Indigo. 17. The Sulphur Dyes. 18. Mordants. 19. Experimental Work. In point of publisher's technique the book deserves the highest praise, and there is a wealth of fully written out structural formulæ. The treatment of the subject leaves nothing to be desired. A number of new prints an an occasional roughness in literary style should be eliminated by tension in a later edition. A curious omission occurs in the index, which, under the entry "Indigo," fails to give the most important reference, namely, that to the chapter on Indigo on page 375. The last portion of the book, pages 417 to 458, forms a laboratory guide for the preparation of some of the typical dyestuffs.

DICTIONARY OF ENGLISH AND SPANISH TECHNICAL AND COMMERCIAL TERMS. By William Jackson. New York: Spon & Chamberlain, 1911. 12mo.; 164 pp. Price, $1.

An excellent idea is embodied in this neat little glossary, for it concerns itself with listing and interpreting the special terms of the iron, steel, hardware, and engineering trades for the benefit of those who are engaged in ordering or in filing orders for these products between English-speaking and Spanish-speaking countries. As it is impossible to find many such technical names in the ordinary dictionary, this compilation should promote ease of commercial intercourse and find favor with a large class of buyers and shippers here and abroad. Between three and four thousand words and phrases are alphabetically listed.

HOW TO MAKE A WIRELESS SET. By Arthur Moore. Chicago: Popular Mechanics Company, 1911. 12mo.; 84 pp.; illustrated. Price, 25 cents.

Boys all over the country are dabbling in "wireless," and many more will take up the hobby when they find how easily a short-distance outfit may be constructed. The instructions here given are for the making of a set that will transmit to a distance of four or five miles.

HOW TO LIVE IN THE COUNTRY. By E. P. Powell. New York: Outing Publishing Company, 1911. 8vo.; 300 pp.; illustrated. Price, $1.75 net.

Mr. Powell is well known as a prolific and sympathetic writer on rural subjects. He speaks from the fulness of an appreciative personal experience, and in this instance tells us how a large life may be lived on a small acreage. Both the dweller in the country and the city man who dreams of farm life may gain strength and breadth of outlook from the author's practical wisdom and inspiring description. The work is primarily a guide to choosing and making the most of a country home. The chapter entitled "Can we make it pay?" touches upon what is to most of us the vital point, and warns while it encourages.

THE BOOK OF ROSES. By Louis Durand. New York: John Lane Company, 1911. 8vo.; 101 pp. Price, $1 net; postage, 8 cents.

The rose is everybody's favorite, symbolical of all the beauty and fragrance of life. Almost any soil can be made to grow roses of one kind or another. The various soils and their preparation forms the theme of the first two chapters. The question of planting is argued, and budding, sowing, and striking as methods of propagation are examined with thoroughness. Much space is given to describing the varieties—wild, autumn-blooming, decorative, and climbing roses. The full-page plates will delight the heart of the flower lover, for they seem almost to exhale the perfume of the specimens they picture.

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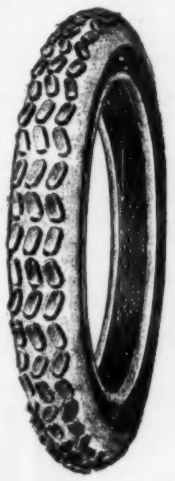

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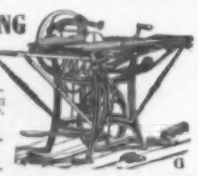

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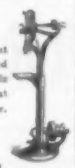

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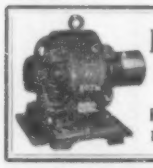

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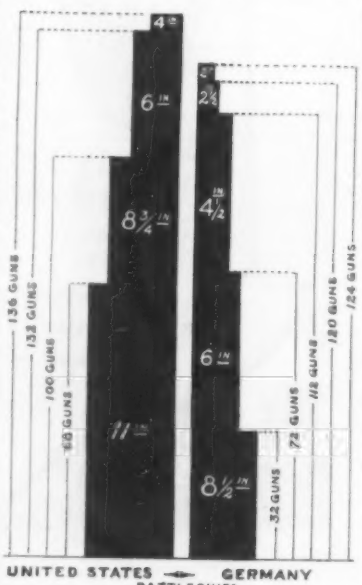
A Comparison of the German and American Navies

(*Continued from page 78.*)

9¾, and ours from 9 to 12 inches—all Krupp armor. The upper sides of all these ships are protected by plates averaging 7 inches in thickness. But the American ships mount main batteries of modern 12-inch guns, against the greatly inferior 11-inch weapon in the Teutons. The eight "Connecticuts" have each a broadside of four 12-inch 45-caliber rifles, which, as we have said, will send a shell through any plates the Germans carry, while the latter's 11-inch 40-caliber weapons are useless against more than 6-inch armor at 8,000 yards! And every one of the five "Georgias" and three "Maines" mounts four 40-caliber 12's which are effective at 8,000 yards against plates 8¾ inches thick.

The remaining ten "Wittelsbachs" and the older Americans are probably of too little offensive value to be seriously considered except for a second line of offense—certain it is, however, that the old 9.4's of the "Wittelsbachs" would be absolutely useless at ranges where the 13's of the "Alabamas," "Kearsarges" and "Indianas" could work fearful havoc with their 1,100-pound shells. The superior speed of the German vessels might indeed enable them to close in upon the Yankees, so as to give their guns a chance, but they would be fearfully punished before they could hope to even matters up in that way.



UNITED STATES — GERMANY
BATTLESHIPS
SHOWING
PENETRATION OF KRUPP ARMOR
AT
8,000 YARDS

This diagram shows that the batteries of United States ships have far greater penetrative power than those of the German ships.

We have hitherto taken no account of the secondary batteries; because so great is the skill to which gun-pointers have attained in recent years that it is doubtful if battleships would fight at ranges at which the lighter guns would be greatly destructive. It is true that they could even at a distance inflict much harm on the unarmored portions of the hull (fore and aft) and upper works, but almost all the complement of a modern battleship are stationed behind armor; and furthermore, the high trajectory of the 8's, 7's and 6's makes it more difficult to hit with them than with the larger pieces.

Armored Cruisers.

When it comes to armored cruisers the navies are more evenly matched. The splendid "Von der Tann" finds no counterpart on our list, more's the pity; and even the "Bluecher" has some advantages over our "Montanas"—as in the matter of speed, for example. But the rest of the Germans are a sorry lot, and our own "West Virginias" are not much better. As for the three "Charlestons"—they are hardly worth mentioning, being utterly useless from an offensive point of view.

In the matter of torpedo-boat destroyers, the Germans are much better off than we are. They have ninety-six of these ready for sea, ranging from the latest models of 620 tons and 34 knots speed to old and slow (25-knot) craft of 400 tons. We possess sixteen 400-tonners of 25 knots speed and twenty brand-new boats of 700 to 750 tons and upward of 31 knots speed.

On the other hand, the American navy has some twenty-six submarines to the German navy's eight; but this kind of craft is more especially adapted to the work of coast defense, and therefore need not be taken into consideration to any great extent.

In fast protected cruisers and gunboats the German navy has a considerable superiority over our own; but however useful the former may be as scouts for the fleet they cannot have any actual value in battle. Therefore we have left them out of our consideration of the relative strength of the two navies.

A summary of broadsides (for modern strategy points to the universal adoption of broadside firing in actions between fleets) of the various groups of battleships, as in the accompanying table, will show at a glance the immense superiority of the American ships in the ability to deal telling blows.

Herewith is given in graphic form a diagram showing the overwhelming superiority of the American battle fleet in the matter of heavy guns; 68, or exactly half of the total, being 12-inch rifles capable of successfully attacking at 8,000 yards the heaviest armor worn by the Germans. On the other hand, not a single one of the Kaiser's ships could at that distance pierce the main belt of any of the Americans, and only 32 of the newest rifles (11-inch, 45-caliber) would be effective against the Yankee topsides.

In time of stress it is the armored ships that count, and the tables given above demonstrate beyond peradventure of a doubt the present offensive superiority of the United States fleet.

Germany is contemplating equipping her newest dreadnoughts with ordnance of 12.2-inch caliber, but these undoubtedly powerful weapons will be more than compensated for by the new 14-inch rifles which are to be mounted in our "Texas" class, recently laid down. All this, however, is beside the question, as our object has been to demonstrate that at the middle of the year 1911, the German navy, far from being a menace, is not by any means the equal, offensively, of the fleet that flies the Stars and Stripes.

Heart Diagnosis by Electricity

(*Continued from page 81.*)

the main circuit. This gives the various "derivations" or "leads": (1) Right arm and left arm, (2) right arm and left foot, (3) left arm and left foot. The wire from the left foot always goes into the same main wire and the left electrode occupies the same position in the circuit as the right arm does, otherwise an inverted electrocardiogram will be obtained. It is necessary to attend to these details, because some diseased conditions cause an inverted electrocardiogram. From the switches the two main wires lead to the galvanometer. In most instances when the patient is connected to the galvanometer, there is a large permanent difference of potential between the two parts of the body (so-called body-current) where the electrodes are attached. This deflects the fiber far to one side, and must be compensated. A commutator is placed in the circuit which serves the purpose of connecting in and sending in either direction around the main circuit a current from a battery (reduced to sufficient strength by a resistance coil). This is sent in the opposite direction to the "body-current," and serves to neutralize the primary body potential, and to effect what is called "compensation of the zero-current."

For making phonocardiograms simultaneously with electrocardiograms, the microphone is wired to a smaller galvanometer. The wiring of the microphone is simple. It is connected with a dry battery in a circuit with the primary of an induction coil. Wires from the secondary lead to the junction points of the wires from the galvanometer and resistance coil. The constant battery current passing through the primary induces no current in the secondary. Changes, however, in the strength of this primary current, as the result of sound vibrations on the

Valuable Books

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Edited by ALBERT A. HOPKINS. Octavo, 1077 pages. 15,000 Receipts. Cloth, $5.00; half morocco, $6.50.

¶ This valuable work is a careful compilation of about 15,000 selected formulas, covering nearly every branch of the useful arts and industries. Never before has such a large collection of valuable formulas, useful to everyone, been offered to the public. Those engaged in any branch of industry will probably find in this volume much that is of practical use in their respective callings. Those in search of salable articles which can be manufactured on a small scale, will find hundreds of most excellent suggestions. It should have a place in every laboratory, factory and home.

Handy Man's Workshop and Laboratory

Compiled and edited by A. RUSSELL BOND. 12mo., 467 pages, 370 illustrations. Price, $2.00.

¶ This is a compilation of hundreds of valuable suggestions and ingenious ideas for the mechanic and those mechanically inclined, and tells how all kinds of jobs can be done with home-made tools and appliances. The suggestions are practical, and the solutions to which they refer are of frequent occurrence. It may be regarded as the best collection of ideas of resourceful men published, and appeals to all those who find use for tools either in the home or workshop. The book is fully illustrated, in many cases with working drawings, which show clearly how the work is done.

Concrete Pottery and Garden Furniture

By RALPH C. DAVISON. 16mo., 196 pages, 140 illustrations. Price, $1.50.

¶ This book describes in detail in a most practical manner the various methods of casting concrete for ornamental and useful purposes. It tells how to make all kinds of concrete vases, ornamental flower pots, concrete pedestals, concrete benches, concrete fences, etc. Full practical instructions are given for constructing and finishing the different kinds of molds, making the wire forms or frames, selecting and mixing the ingredients, covering the wire frames, modeling the cement mortar into form, and casting and finishing the various objects. With the information given in this book, any handy man or novice can make many useful and ornamental objects in cement for the adornment of the home or garden. The information on color work alone is worth many times the cost of the book.

The Design and Construction of Induction Coils

By A. FREDERICK COLLINS. Octavo, 295 pages, 159 illustrations. Price, $3.00.

¶ This work gives in minute detail full practical directions for making eight different sizes of coils, varying from a small one giving a one-half-inch spark to a large one giving twelve-inch sparks. The dimensions of each and every part down to the smallest screw are given, and the directions are written in language easily comprehended. Much of the matter in this book has never before been published as, for instance, the vacuum drying and impregnating processes, the making of adjustable mica condensers, the construction of interlocking reversing switches, the set of complete wiring diagrams, etc. The illustrations have all been made from original drawings, which were made especially for this work.

Industrial Alcohol Its Manufacture and Uses

By JOHN K. BRACHVOGEL, M.E. Octavo, 528 pages, 107 illustrations. Price, $4.00.

¶ This is a practical treatise, based on Dr. Max Maercker's "Introduction to Distillation" as revised by Drs. Delbruck and Lange. It comprises raw materials, malting, mashing and yeast preparation, fermentation, distillation, rectification and purification of alcohol, alcoholometry, the value and significance of a tax-free alcohol, methods of denaturing, its utilization for light, heat and power production, a statistical review and the United States law. This is one of the most authoritative books issued on the subject and is based upon the researches and writings of the most eminent of Germany's specialists in the sciences of fermentation and distillation. It covers the manufacture of alcohol from the raw material to the final rectified and purified product, including chapters on denaturing, domestic and commercial utilization.

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microphone, set up induced currents in the secondary, and these are recorded by the galvanometer.

In healthy people the electrocardiogram assumes, in the majority of instances, a certain typical form. The term "typical" or "schematic" is used instead of "normal," since slight deviations from it may occur in people with normal hearts. When any muscle is excited to contract, the active portion is always electrically negative to the part at rest. This is true, therefore, in the heart, and electrical changes show the course of excitation. The curve for each heart period presents throughout three principal waves upward, indicating an electrical negativity of the base of the heart with regard to the apex at three different instants in a single cardiac cycle. These three elevations have been designated by Einthoven as *P, R.* and *T*. The curve presents, also, in many instances, two slight excursions or waves downward, depressions, indicating a negativity of the apex of the heart with regard to the base at two different instants in each cardiac cycle. These two depressions, though less constantly present than the three elevations, have been designated by Einthoven as *Q* and *S*.

By the course and height of these waves, as shown in the records, the physician can tell by eye whether the heart undergoes normal electrical changes or abnormal; in the latter instance an analysis of the abnormal appearances of the record throws light upon the disease of the heart-muscle which is present.

The two accompanying illustrations will give a clearer conception of the method of observation. The upper of the two diagrams is an electrocardiogram. The lower is a diagram, on an enlarged scale, of a section of the electrocardiogram, which will make plainer the changes in a single cardiac cycle. Waves with the apex upward indicate that the base of the heart or the right ventricle is negative to the apex or left ventricle, and is therefore excited at that time. Waves with the apex downward have an opposite significance. Wave *P* is due to the excitation of the atrium (or auricle). Waves *Q. R. S* and *T* occur during the excitation of the various portions of the ventricle.

What this instrumental investigation signifies not only for the discovery of disease, but also for diagnosing its precise character, it is as yet too early adequately to judge, but many physiologists and physicians believe that it will prove to be a very valuable aid to the medical profession. While the galvanometer, the photographic recorder and the auxiliary instruments have in this country already furnished data of importance in connection with animals as well as human beings, the work in Europe has been far more extensive, as a larger number of stations have been established.

Light-producing Bacteria and Fireflies

A FEW years ago Prof. Molisch determined that of all the light-producing bacteria *Pseudomonas lucifera* produced the brighest light. F. Alexander McDermott presented before the Biological Society of Washington the results of his own further experiments with this organism. A culture of these bacteria was sent to Washington by Prof. Molisch, so that the form used was identical with the original material.

Mr. McDermott finds that the bacteria will grow in gelatin or a liquid medium, doing better however in gelatin; in all cases it needs the presence of from 2.5 to 3 per cent of common salt, or certain other mineral. A culture will continue to give off light actively for about a week, reaching the maximum 48 hours after inoculation. The light is a soft green of "considerable intensity." The following formula furnished the best culture medium: Peptone, 1 per cent, Asparagin, 1 per cent, Magnesium chloride 0.5 per cent, Sodium chloride 2.5 per cent, Glycerine 0.5 per cent.

Solutions of greater concentration were not so favorable to the growth of the bacteria, and Mr. McDermott suggests that the organism is "apparently sensitive to overfeeding." It is perhaps simply an indication, however, of the osmotic limits of the minute cell.

The spectrum of the light emitted runs from yellow-orange to indigo and is less constant than the light from certain fireflies, though similar in appearance to the naked eye. Although the light from cultures in a liquid medium looked whiter to the eye, the spectrum was the same.

The luminous tissue of fireflies had already been shown capable of again emitting light when moistened, after having been dried in a hydrogen vacuum—even after the lapse of from thirteen to eighteen months. It had also been found that the light was brighter when the tissue was moistened with hydrogen peroxide solution. Similar results are now reported for dried cultures of *Pseudomonas*. Oxygen under pressure also restored the luminosity.

The general character of the light produced by the firefly and by these bacteria is the same, but there is no reason to suppose that the process by which it is produced is the same in the two cases. But it is probable that the luminosity is connected with oxidation in both organisms.

The Current Supplement

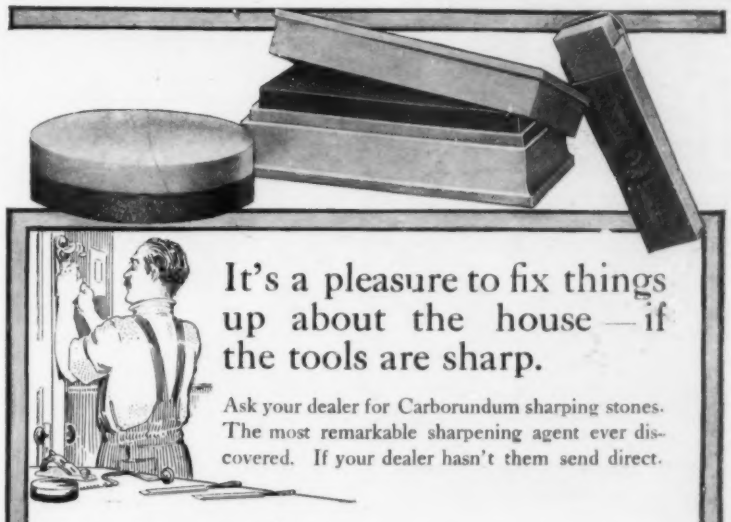
THE opening article of the current SUPPLEMENT, No. 1855, deals with the Grand Trunk Transcontinental Canadian Railway.—Major George O. Squier's paper on Multiplex Telephony and Telegraphy is continued.—The heat-insulating efficiency of vacuum-jacketed bottles is discussed by A. A. Somerville.—Commandant Renard's paper on "What Constitutes Superiority in Airships" is concluded.—Before the Society of German Marine Engineers, the contributions of Goethe to science and industry are considered.—Jacques Boyer writes on the application of the Dussaud principle of illumination to moving picture projection.—The Berlin correspondent of the SCIENTIFIC AMERICAN describes an apparatus for recording loss in weight.—The possibilities of aeroplanes in naval warfare are discussed by a German naval officer.—Illustrated descriptions of automobile novelties are presented.—Ralph C. Davison writes on the enormous discharge of dynamite rendered necessary in the construction of the new cut-off of the Delaware, Lackawanna and Western Railroad near Andover, New Jersey.—A good article on toxicology is contributed by Professor Levin, of the University of Berlin.

The Secret of the Maple

IT is probable that every observant person who has visited a maple-grove in the early spring, while snow-banks are yet lingering in sheltered hollows, and has seen pailful after pailful of sweet sap drawn from the auger-holes in the trunks, has wondered what forces govern the flow of the sap.

When the warm sun touches the tree-tops the flow increases. A rise of a few degrees in temperature often causes a great increase of flow, if the rise passes the zero-point, on the Centigrade scale, that is, the freezing-point of water. But a considerable change of temperature in which the fluctuations do not cross the zero line causes no marked change in the flow of the sap. In the consideration of these and other related facts, the conclusion has been reached that neither expansion of gas in the wood, nor expansion of water, nor expansion of the wood itself, is the underlying cause of the pressure which produces the flow, but that this pressure arises from the effects of temperature in altering the osmotic permeability of the pith-ray cells.

A New Route Across Africa.—The German Government is rapidly progressing with the railroad that is to connect Daressalam with Tabora in German East Africa. A force of 10,000 laborers is at work on the new road, of which 374 miles have been constructed. According to the *Deutsch Ostafrikanische Zeitung* the ultimate extension of this road to Ujiji, on Lake Tanganyika, is practically assured. As the Belgians have now decided to extend their upper Congo railway system to the west shore of Tanganyika, the time is not far distant when it will be possible to travel by rail, lake and river across Africa from Daressalam to the mouth of the Congo.



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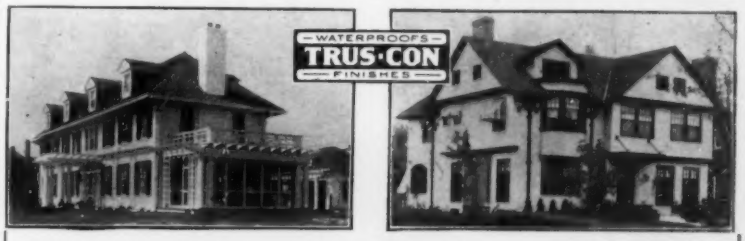

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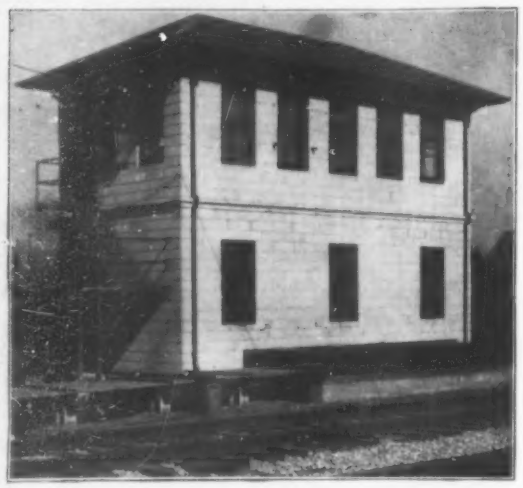

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CONSERVATION

The AUGUST Magazine Number of the SCIENTIFIC AMERICAN Issue of AUGUST 12th, 1911

The next magazine number of the Scientific American, August 12th, 1911, will contain a series of articles by leading authorities, which will deal with this vital subject of the conservation of our natural resources.

Ex-Chief Forester the Hon. Gifford Pinchot, whose earnest fight for the preservation of the coal lands of Alaska has led to a favorable decision of the Land Office, which greatly strengthened the cause of conservation, will open the number with an article on the Conservation of our Forests.

The Director and Chief Engineer of the Reclamation Service, F. H. Newell, will write a general article on the past work and future plans of the Reclamation Service.

The Director of the Bureau of Mines, Dr. Joseph A. Holmes, will show that the waste of our supplies of coal is due not merely to careless and extravagant management in the mining of the coal, but also and very largely to methods in burning the fuel.

Dr. David T. Day, of the United States Geological Survey, will prove, in an article on the conservation of oil and gas, that, as with coal, so with oil and gas, it is possible to effect large economies by judicious management in the oil and natural gas fields and by the use of improved appliances in burning these fuels either for light or power purposes.

Dr. Hugh M. Smith, Deputy Commissioner of Fisheries, will contribute an article on the Conservation of Fish, Oysters, etc., and Seals. Conservation is a word to which we are liable to give too restricted an application.

In addition to the above articles, the August 12th number will contain the usual Editorial, Aviation, and other Departments.

Electricity

Unloading Bananas by Electricity.—Fruit steamers in New Orleans and Mobile are now being unloaded by means of electric conveyors. The conveyors are provided with vertical legs that enter the hatches of the vessel. These legs support traveling chains four feet apart, which are connected by cross bars carrying canvas pockets. Bunches of bananas are placed in these pockets and hauled out of the vessel. The loading of the conveyor is performed from three decks, each deck filling every third bag. Each conveyor has a capacity of twenty-five hundred bunches of bananas per hour.

Avoiding Pole Lines in a Welsh Town.—In order to avoid the use of poles in the streets of a town in Wales, it was decided to run the wires on brackets supported on the sides of the buildings and the roofs. The brackets are made of angle iron and extend about six feet from their support. At first there was some hesitation on the part of owners about giving the right of way over and along their buildings, but this was overcome by proper precautions on the part of the company. The system has proved very successful, and it avoids crowding and disfiguring the streets with poles.

Outdoor Ironing.—One of the most dreaded days of the household in summer time, is ironing day. Even though electric flat irons are used, the heat may become almost unbearable owing to the fact that the work is invariably done indoors. The Commonwealth Edison Company of Chicago does not see why the ironing should not be done outdoors on the porch, or in some other convenient location. All that is needed is a sufficiently long conductor to conect the flat iron with a lamp socket in the house. This idea has been seized upon to provide a very attractive circular showing the advantages of outdoor ironing and incidentally advertising the use of electricity for this branch of the house work.

Electric Fans for the Sick.—According to popular impression public service corporations are organized robbers. It is almost impossible to combat this prevailing idea. Recently, however, the Electric Supply Company of DeKalb, Ill., has demonstrated that it can perform a work of charity in which there is no personal gain whatsoever, except for creating a better feeling on the part of the public toward it. The company has notified all the physicians in the city that it will furnish electric fans and power to operate them without charge, to all patients who are unable to pay for such service and who, on the suggestion of the physician would be materially benefited by the use of fans. This applies not only to such houses as are wired, but to others as well, the company offering to install the necessary circuits, gratis.

New Lighting Apparatus.—A very economical method of producing light by means of small incandescent lamps was shown by M. Dussaud before the French Academy of Sciences. He mounts 16 small lamps with one-inch bulbs around the edge of a revolving disk, provided with a set of contacts so arranged that when the disk rotates each lamp receives current for a fraction of a second. It is well known that tungsten lamps have the property of lighting up very quickly when the current is applied. He uses a 10-volt lamp and it receives 20 volts, or much more than the normal current, but for a very short time. Much more light is thus given for the same amount of current. Each lamp in turn passes when lighted before a fixed lens so as to project the rays, and as the lamps pass rapidly the light seems continuous. His main object is to provide a suitable light for lantern projections, and he claims to secure a light equal to an arc lamp for a very small current such as a moderate-sized primary battery will give. Thus it can be used where there are no current mains at hand. It is well adapted to be used as a small searchlight upon fishing boats or to be carried by soldiers, and for army use the battery can be placed in a sack upon the shoulders, together with an optical signaling outfit. Such an outfit can be used also upon aeroplanes.

Science

Death of G. Johnstone Stoney.—Dr. G. Johnstone Stoney died recently at the age of 85. He had been astronomical assistant to the late Earl of Rosse in 1848, professor of natural philosophy in Queens University, Ireland, in 1852, and secretary of Queens University from 1857 until its dissolution in 1882. He was known chiefly for his writings on astronomy.

An Opera Glass Comet.—We have received a communication from Prof. Edward C. Pickering of Harvard College Observatory, in which he states that a comet has been discovered by Kiess on July 6th in R. A. 4 h. 51 m. 51.8 s., Dec. 35 deg. 15 m. 2 s. The comet can be seen with an opera glass, and at the time of its discovery was moving southwest and had a visible tail.

Color Photography.—A patent, 992,151, has been issued to Rodolphe Berthon of Lyon, France, for a color photography apparatus which comprises an objective with a diaphragm therein having a trichromatic screen, a sensitive surface and means interposed between the sensitive surface and the objective so that the images on the screen are separated by refraction at points in close proximity and projected in a microscopic state on the sensitive surface.

The "International Week" of Upper Air Observations.—A circular from the headquarters of the International Commission on Scientific Aeronautics announces that, owing to the fact that the attention of British as well as many foreign meteorologists will be taken up with the meeting of the British Association during the early part of September, the dates set for the "international week" of aerological observation throughout the world, in 1911, have been changed from September 5-9 to September 11-16.

A Meteorological Outpost in the South Atlantic.—An important addition to the meteorological *réseau* of the southern hemisphere was made early this year in the establishment of a meteorological station of the first order in Fernando de Noronha, a little group of islands about 194 miles northeast of Cape St. Roque, on the Brazilian coast. The islands are used by Brazil as a penal colony, and contain upward of two thousand inhabitants. Darwin has described a visit here in the "Beagle," and the "Challenger" also touched here. The station is under the charge of two German employees of the Brazilian telegraph service, and sends daily telegraphic reports to Rio de Janeiro.

The Flight of Seeds.—It is popularly believed that winged seeds from trees travel to great distances on the wind, but the investigations of a British scientist, who has spent much time at Singapore, indicate that winged seeds have a far narrower range of flight than have "powder" seeds and plumed seeds. The greatest distance traveled by the winged seeds of a forest tree observed by this authority was 100 yards. Under the most favorable circumstances, he calculates, it would take this plant just one hundred years to spread three hundred yards, and 1,500,000 years to spread from the Malay Peninsula to the Philippines, if a land connection existed.

Illumination with Neon Tubes.—M. Ch. Ed. Guillaume recently lectured before the Astronomical Society of France on the subject of neon light. Neon, one of the rare gases of the atmosphere, is now obtained on a commercial scale in the process of making liquid air. In a vacuum tube it has several excellent qualities as an illuminant. Owing to its extraordinarily feeble dielectric cohesion the voltage required is relatively small. M. Guillaume exhibited a tube six meters long, which was illuminated with a current of 1,000 volts. A light of 1,320 candle-power was produced, with an expenditure of only 850 watts, or 0.64 watt per candle-power. The light, which is of a warm golden yellow, is described as being peculiarly pleasing. The lecturer also described a process of removing from the tube traces of other gases, especially nitrogen, the presence of which seriously diminishes the illuminating power of the neon.